Thos. D. Hemphill,

Livingston,

Ala.

Spring Term 1929

time
when
after
before
why

place
where

2 reasons
physiological
Psycological
condition
&c

Causation
though
although

purpose
that
in order that
before
as

evidence
since
because
far

15-1
60
40.60

45
30
30
30
40
30

205

205

16 1/2
15 1/2
18
.1/2

35 cards on which were [illegible]
& Cities large enough to be
seen in room.

Bertha Lee Wilson

Evelyn Hatch

Evely Hatch

Evelyn Hatch

Alma Pilot
Cecil Granade

E.V.J.

Al.

Evelyn Hatch

Evelyn Hatch

Evelyn Hatch

M.

E Evelyn E Ha

Evelyn Hatch

Baringer, Alabama
Frankville
Silas

Ruby Lea Robinson
Montevallo
ALA.

7 2
2
9 3

Harvey
circulation of blood

Evelyn Hatch

Evelyn Hatch

Bertha Lee Wilson 1929

1st Experiment	25½	
2nd ,,	27	
1st test	26	
total	78	30 C
3rd Experiment	22½	
2nd test	25	
	125½	

RIVERSIDE TEXTBOOKS IN EDUCATION

EDITED BY ELLWOOD P. CUBBERLEY

PROFESSOR OF EDUCATION
LELAND STANFORD JUNIOR UNIVERSITY

1 - 10
2 - 6
3 - 2
4 - 8
5 - 1
6 - 3
7 - 4 ✓
8 - 9
9 - 7
10 - 5

1 - T
2 - F
3 - T
4 - T
5 - F
6 - T
7 - T
8 - F
9 - T

ELEMENTS OF EDUCATIONAL PSYCHOLOGY

BY

LAWRENCE AUGUSTUS AVERILL, PH.D.

PROFESSOR OF PSYCHOLOGY IN THE MASSACHUSETTS
STATE NORMAL SCHOOL AT WORCESTER
AUTHOR OF PSYCHOLOGY FOR NORMAL SCHOOLS

Problem, attentive & suggestible attitudes

HOUGHTON MIFFLIN COMPANY
BOSTON NEW YORK CHICAGO SAN FRANCISCO
The Riverside Press Cambridge

COPYRIGHT, 1924
BY LAWRENCE AUGUSTUS AVERILL

ALL RIGHTS RESERVED

The Riverside Press
CAMBRIDGE · MASSACHUSETTS
PRINTED IN THE U.S.A.

Look on page 93 and you will see a terrible [illegible] So

Look on page 234 and you will see the name of the one dope.

EDITOR'S INTRODUCTION

While it is generally recognized in principle that the art of teaching must be based on the science of psychology, the practical application of this principle to normal-school procedure has not always been made. The psychology that has been taught in our normal schools has often gone to one or the other of two extremes. Most commonly it has been philosophical and adult in type: sometimes it has partaken of the nature of a laboratory science, and with experiments of but little value for education. In the first type of course the actual schoolroom situations of a teacher with little children have not been dealt with: in the second type of course the experiments performed have had little or no relation to problems concerned with the fundamental instincts of children or the genesis and growth of their thought processes.

Within recent years there has been a commendable tendency on the part of normal-school teachers of psychology to break away from the traditional lines of instruction in the subject, and to provide students in training to become teachers with a type of psychology that applies the fundamental principles of the science to the classroom problems of the teacher. The past half-dozen years have seen the appearance of a number of textbooks having this aim in view, and written in language as free from technical terms as is possible. One of the most successful of these recent books, judged from its sales, has been the present author's *Psychology for Normal Schools*, published three years ago. Representing, as it did, the consensus of opinion of a body of normal-school teachers of the subject as to what a course in elementary psychology should contain, it presented a simple and direct treatment that has won for it an important place as a textbook in the normal schools of the United States.

The author has now followed this earlier book with the present volume, which applies the general principles of psychology as a science, such as might be learned in any good general introductory course in the subject, to the classroom problems of the teacher in our elementary schools. Written as it is in a simple and forceful style, based as it is on the results of scientific investigations, and with conclusions applied directly to schoolroom conditions and needs, this new volume in this series of textbooks ought to prove at least equally as successful as its predecessor. In a brief but excellent final summary the author points out how largely, after all, education is a process of producing desirable changes in children, and shows how fully teaching is an art, but an art based on the results of scientific research.

Ellwood P. Cubberley

FOREWORD

THE reception given the writer's previous volume in this series, *Psychology for Normal Schools*, has been so gratifying that he has been emboldened to submit to the verdict of teachers of psychology this companion volume, which represents an epitome of his own course in educational psychology. It is intended primarily as a textbook for teachers-in-training who have had a general introductory course in psychology, and who should now be ready for a more strict application of its cardinal principles to actual schoolroom situations. Just as in the introductory course it was deemed highly desirable that the psychology of the training school be based, as far as possible, upon direct observation of the behavior of children, so in this subsequent course in educational psychology it has been considered as desirable that the work be given a definitely experimental basis.

The time is happily past, or at least is rapidly passing, when psychology is to be included in the curricula of teacher-training institutions purely as a philosophical subject. The chief explanation of the long persistence of a sequestered, academic psychology in these institutions is to be found in the lack of a working familiarity on the part of many instructors with the involved technique of experimentation; in the unfortunate fact that such laboratory manuals as have been available often required too expensive equipment and apparatus to make them attractive to normal schools; and in the somewhat doubtful wisdom of changing the emphasis, in the young teacher's study of psychology, from philosophical speculation to an elaborate laboratory science which bears no direct and little indirect relationship to the teaching of boys and girls. With the appearance of more modest laboratory manuals, definitely projected in the direction of the schoolroom, and requiring not only a simpler technique but also less expensive and delicate apparatus, these limitations upon a "functioning" normal-school psychology are now happily removed, and the best teachers of the subject are to-day working their way rapidly toward a vastly more defensible and practical ideal in their teaching.

It has been the ambition of the writer, in the preparation of this volume, to present the chief features of his own course in educational psychology for second-year students. Such topics as easily so lend themselves have been subjected to experimentation, the technique of which has been kept as simple as possible. Whatever materials are needed can be prepared in all cases, either by the instructor or the student. It is confidently believed that every one of the thirty-two experiments comprising the course will be found of distinct value in orienting the viewpoint and interest of the future teacher to the general educative process.

With the experiments, and with its minimum list of selected references and special problems appended to each of the seventeen lessons, the book is designed to embody a full semester's intensive work.

Lawrence A. Averill

SELECTED BIBLIOGRAPHY

A Reference Library for Supplementary Use in Connection with this Manual

Only those books to which the student is referred in the ensuing lessons are included, and they should represent the minimum of outside reading required. Titles marked by the star (*) are included rather for occasional reference than for regular use.

1. Angell, J. R. *Introduction to Psychology.*
2. Averill, L. A. *Psychology for Normal Schools.*
3. Bagley, W. C. *Educational Values.*
4. Bagley, W. C. *Classroom Management.*
5. Betts, G. H. *The Mind and Its Education.*
6. Book, W. F. *Psychology of Skill.*
7. Breese, B. B. *Psychology.*
8. *Cannon, W. B. *Bodily Changes in Pain, Anger, Fear, and Rage.*
9. Charters, W. W. *Methods of Teaching.*
10. Colvin, S. S. *The Learning Process.*
11. *DeGuimps, R. *Pestalozzi, His Aim and Work.*
12. Dewey, John. *School and Society.*
13. Dewey, John. *How We Think.*
14. Dewey, John. *Interest and Effort in Education.*
15. Earhart, L. B. *Types of Teaching.*
16. Freeman, F. M. *How Children Learn.*
17. Gordon, K. *Educational Psychology.*
18. Hewins, N. P. *The Doctrine of Formal Discipline.*
19. Horne, H. H. *Psychological Principles of Education.*
20. *James, W. *Principles of Psychology,* Vol. I.
21. James, W. *Psychology: Briefer Course.*
22. *Judd, C. H. *Psychology.*
23. Kilpatrick, W. H. *The Project Method.*
24. Kirkpatrick, E. A. *Studies in Psychology.*
25. La Rue, D. W. *Psychology for Teachers.*
26. McCall, W. A. *How to Measure in Education.*
27. McMurry, F. M. *How to Study.*

28. Meumann, E. *Psychology of Learning.* (Tr. by Baird.)
29. Miller, H. C. *The New Psychology and the Teacher.*
30. Monroe, W. S., DeVoss, J. C., and Kelly, F. J. *Educational Tests and Measurements.*
31. Offner, M., and Whipple, G. M. *Mental Fatigue.*
32. O'Shea, M. V. *Education as Adjustment.*
33. *Parker, S. C. *History of Modern Elementary Education.*
34. Pillsbury, W. B. *Essentials of Psychology.*
35. Pyle, W. H. *The Psychology of Learning.*
36. *Rousseau, J. J. *Émile.*
37. Rugg, H. O. *Statistical Methods Applied to Education.*
38. Starch, D. *Educational Measurements.*
39. Starch, D. *Educational Psychology.*
40. Strayer, G. D., and Norsworthy, N. *How to Teach.*
41. Strong, E. K. *Introductory Psychology for Teachers.*
42. Swift, E. J. *Mind in the Making.*
43. Terman, L. M. *Hygiene of the School Child.*
44. Terman, L. M. *The Intelligence of School Children.*
45. Thorndike, E. L. *Educational Psychology.* Vol. I, *The Original Nature of Man.* Vol. II, *The Psychology of Learning.* Vol. III, *Individual Differences.*
46. *Thorndike, E. L. *Animal Intelligence.*
47. Warren, H. C. *Elements of Human Psychology.*
48. *Watson, J. B. *Behavior, Etc.*
49. *Whipple, G. M. *Manual of Mental and Physical Tests.*
50. *White, W. A. *The Principles of Mental Health.*
51. Wilson, H. B., and Wilson, G. M. *Motivation of School Work.*
52. Winch, W. H. *Children's Perceptions.*

Reference is also made constantly, in the following lessons, to the files of the leading psychological and educational periodicals; also to Monroe's *Cyclopedia of Education.*

CONTENTS

PART I

THE MOTIVATION OF LEARNING

LESSON PAGE

1. THE URGE OF INSTINCT 3
2. THE SIGNIFICANCE OF MOTIVATION 18
3. MENTAL ATTITUDE: AN IMPORTANT FACTOR IN MOTIVATION 38

PART II

THE LEARNING PROCESS

4. SOME GENERAL CONSIDERATIONS 61
5. TWO GOALS IN LEARNING: HABIT AND KNOWLEDGE . . 81
6. HUMAN AND ANIMAL LEARNING 101
7. THE LEARNING CURVE 130
8. SENSORI-MOTOR AND PERCEPTUAL LEARNING . . . 153
9. ASSOCIATIVE LEARNING 179
10. ASSOCIATIVE LEARNING AND PROBLEM-SOLVING . . . 202
11. INITIAL PHASE OF LEARNING: IMPRESSING THE DATA
    1. FREE AND FORCED ATTENTION 230
12. INITIAL PHASE OF LEARNING: IMPRESSING THE DATA (*continued*)
    2. LEARNING CAPACITY AND FATIGUE 257
13. INITIAL PHASE OF LEARNING: IMPRESSING THE DATA (*concluded*)
    3. THE PSYCHOLOGY OF ATTENTION 280
14. SECONDARY PHASE OF LEARNING: RETAINING THE DATA
    1. MEMORY AND MEMORIES 298
15. SECONDARY PHASE OF LEARNING: RETAINING THE DATA (*concluded*)
    2. FORGETTING, IDEATION, AND TRAINING 319

PART III

THE RESULTS OF LEARNING

16. The Transference of Training 347
17. Building a Well-Adjusted Personality 376

APPENDIX

Measurement and Tabulation of the Results of Learning 391
Index 417

ELEMENTS OF EDUCATIONAL PSYCHOLOGY

∴

PART I

THE MOTIVATION OF LEARNING

ELEMENTS OF EDUCATIONAL PSYCHOLOGY

∴

LESSON 1

THE URGE OF INSTINCT

Great mainsprings of action. This afternoon I watched a company of boys playing football in a vacant lot. They did not wear the regulation uniforms, it is true; nor was there any half-back, or yet any quarter-back. There did not appear even to be two sides. But for all that, it was real football just the same. The hoarse shouts from throats all but worn-out with overwork echoed and reëchoed through the wood near by, for all the world like the rooting of enthusiastic fans at an orthodox contest. Flying feet coöperated with straining necks and grasping hands and leaping bodies to make the touchdowns. Exclamatory cries of derision greeted some poor unfortunate player who failed to make good at the supreme moment of holding the spinning ball, while vociferous shrieks of approval were accorded the more clever players who gripped and held it fast against wildly beating breasts. Violent disputes arose occasionally over the succession of "kicker-outs," as they termed the quarter-backs, but these seemed to adjust themselves speedily to the satisfaction of all concerned.

As I watched these excited players through my window, I was keenly impressed with the fact that there were no laggards there. Every last boy was playing his level best. There was no reserve, no timidity, no hesitation, no holding back. Even James and Henry, whom I very well knew to be notorious idlers in the schoolroom, were transformed under the influence of the sport into personified eagerness itself, and it required no very attentive observation to discover that James was the very-much-looked-up-to leader of the whole group of football dervishes. And this same James failed of promotion last June! Thoughtfully I turned away from the window and back to my work, but the gleeful voices continued to bear convincing witness to the delight of the boys without, and before their hilarities were interrupted by dusk and the call to supper, I fancy there were many aching muscles and many tired feet and arms in that rollicking group of youngsters.

The case was no different yesterday with two industrious five-year-olds in my back yard. I was busy constructing a trench in which some shrubs were to be set out, and for a time was not aware of what they were doing. But before very long my attention was attracted by their pointed dialogue to a trench that they, too, had begun to make in the garden near by. For a time they worked with only their own little spades and shovels, but quite soon they came over and hovered about me with the shyly polite invitation that I loan them my larger tools. And so heavy spade and shovel and clumsy pick-axe all found their way as I finished with them to the children's corner of the yard. Fingers that could reach scarce halfway round the handle tugged the pick aloft, poised it over a projected section of the trench, and then let it descend willingly enough into the soft earth. When Edwin grew tired, Harold was only too eager to relieve him; and when Harold could no longer raise the ponderous implement, Edwin was quite as ready to swing it as before.

Little by little the pit grew in depth until it became evident that the excavators had changed their minds (in that delightfully irresponsible manner of childhood) about making a trench, and were resolved upon digging a hole as deep as ever they could! Shovels almost as large as their plyers struggled up anon from the deepening crater with a cup full of dirt at a time, half of which promptly dropped back into the hole. Occasionally a goodly stone was come upon, and the united efforts of both children were required to remove it from its bed. Surely more than two hours sped by, and still they were hard at work. Between shovels, however, I noticed Edwin pausing now and again to regard with some consternation incipient blisters that were rising on his palms. Harold's hands appeared to be made of sterner stuff, for, aside from furtive glances at Edwin's blisters, all his energies were directed upon the manipulation of spade or shovel or pick. Frequently both children paused for a moment to rest. But even during their brief rest periods it was plain that they were planning their next point of attack upon their problem.

By supper-time, so indefatigable had been the zeal of the infantile excavators that all that could be seen in their corner of the garden was a crater-like cone which erupted intermittently little puffs of dirt from its cavernous depths!

Can we harness this energy? What patience here! What industry! What perseverance! Why should tender children forsake their carts and their blocks and their trains of cars to delve down into Mother Earth all afternoon? What motive should prompt them to pit their scant strength against cumbersome pick and shovel and rock and unyielding dirt? Why should silk-soft skin mar itself with callus and blister and grime? Did it ever occur to you that teachers, if they were only clever enough at their art, might so interest boys and girls in the work of the schoolroom that they would be eager to throw themselves into it with just as much enthusiasm and just as much abandon as they do into their play? Surely it is no more difficult, no more exhausting, to follow out a project in arithmetic or in hygiene for an hour than it is to spring after a football or to dig in the garden.

The whole secret of maintaining the attentiveness and the interest of children at high pressure, whether in school or out, lies in the nature of the appeal which the task at hand offers to them. Is it, then, not possible to introduce into our school life motivation of a nature similar to that which operates on the ball field, or in the back yard, or on the playground? Can we not, in other words, harness this overflowing energy that everybody knows exists in boys and girls during the happy hours when they play and romp and argue together, and turn it into schoolroom channels? Or must all this superfluity of energy and activity — yes, and intense interest — remain untapped so long as boys and girls are restrained within the schoolroom?

To answer these questions is to call to witness Nature's greatest driving forces: the instincts. It is they largely that impel boys and girls to action. In the football game they appeared as rivalry and display; in the trench-digging they took the form of curiosity and constructiveness. Wherever an activity is dependent upon them for its carrying forward, there is not likely to be either lingering or sloth. They comprise the original motive power of the whole learning process. Children are after all but restless steam-engines whose throttles are the instincts: open them a trifle and the steam rushes into the cylinders, causing the wheels of action to revolve; pull them wide open and they spin madly ahead. Neglect to open them and only some externally applied force will turn the wheels. Apply the metaphor: if we leave the instincts out of account in the teaching of children we shall be laboring with lifeless and inert people whose self-propelling force is dead. On the other hand, if we take special pains to attach our instruction artfully to some natural tendency we may hope and expect to find pupils ready and eager to respond.

Some important instinctive forms of response. There are a considerable number of instinctive forms of behavior with which we as teachers are not directly concerned, although we should bear clearly in mind that every one of them exerts a marked influence over the development of the child. We are particularly interested, however, in some half-score or more instinctive types of response which vitally influence the growth and behavior of children of school age. They are the following: (1) the thirst for activity, both mental and physical; (2) the thirst for nomadic adventure; (3) the thirst to possess or own; (4) the thirst to collect and amass; (5) the thirst for companionship and the stimulus of the group; (6) the thirst for play; (7) the thirst for approbation and praise; (8) the thirst to excel; (9) the thirst to investigate; and (10) the thirst to dramatize or imitate.

The close interrelationship of the instincts. Before proceeding to examine possible ways of utilizing these inborn tendencies in the educative process, however, we should first understand that an instinct exists in isolation but rarely. We say ordinarily that a group of children who are enjoying themselves are actuated primarily by the play instinct. But the play response is by no means so simple and unadulterated as we might suppose. In the play situation there are likely to be present several related instincts, each of which greatly intensifies and complicates the behavior of the group. The boys, for example, who were participating in the football game about which we spoke above were giving outlet in their play not alone to the general play response, but likewise to the rivalry response, the social or gang response, the display and approval responses, and perhaps some others.

Ultimately, then, the play instinct is a composite term including within its meaning many supplementary instincts, such as those enumerated in the preceding paragraph. A child's behavior in any given situation, then, cannot be always or even often explained in terms of any one innate tendency seeking outlet. To play is to rival, to compete, to "show off," to hunt, to migrate, to manipulate, to imitate, and to manifest the impulsion of several or all of these responses more or less simultaneously. Even in the case of Edwin and Harold delving down into the earth with their shovels and spades, the curiosity response and the imitative response as well as the manipulative were all in evidence, and each was contributing its share to the appealingness of the task in hand.

Since, therefore, the instincts are thus mutually supplementary, whatever illustrations may be given in subsequent lessons of putting the instincts to work in order to lend zest and enthusiasm to the schoolroom situation will necessarily be illustrative, not of any particular tendency, but more properly of several merged together. Instinctive tendency is a dynamic influence in boys and girls, leading now to this expression, now to that. At one time it may appear predominantly as rivalry; at another as curiosity; and at still another as display, but more often, perhaps, it would be impossible to say which tendency, if any, is uppermost.

Instinctive urge is Nature's cardinal motivation. All this original equipment of instinctive thirsts, as we said at the outset, represents the great basic mainsprings of action in boys and girls, and, when modified and disciplined by will and habit, of grown-ups as well. The motivation, in other words, back of the trench-digging and the ball-playing and all the rest of the childish "tumult and shouting" is nothing more or less than hungering and thirsting after instinct-satisfiers. It is only with the modification of original forms of behavior, that comes with experience and adjustments of more mature years, that the impulsion of this inner urge becomes unified with the dictates of the rational, deliberative self. And even then the instincts are by no means submerged, but remain, though imprisoned for the most part within the walls of habit, fundamental determinants of adult behavior. Your newspapers are filled daily with accounts of crimes and delinquencies and indiscretions which result when some of these too-loosely-imprisoned primal instincts break away and wreak destruction and suffering among men.

In normal children the instinctive thirsts become considerably modified when they come in contact with the social experiences with which at every turn the child is confronted. In its naked form an instinct is simple, single, and direct in its urge after satisfaction. It is absolutely blind, absolutely unconscious, absolutely specialized. Under the full stress of its influence the individual's behavior is conditioned absolutely. As such, an instinct is seen at its best and only pure form in the animal. As a result of social experience, group participation, training, thought, and the development of a modicum of will (seen only in human beings), however, the instinct evolves from its native level of blind tyranny over the individual to an appreciably higher level, where it passes to a considerable degree under conscious control. From the rôle of master it is metamorphosed under social discipline to that of servant, without thereby yielding up its indispensability in the social adaptiveness of the individual. From exerting a specialized influence, resulting in a specialized response, it comes to be coördinated with other original tendencies and acquired habits to the end that the behavior of the individual may be unified and harmonious, although extremely ramified and complicated. From simple, blind, unconscious urge, it becomes complex, purposive, conscious urge. It is therefore highly important for the teacher of children to be fully aware that every act of the normal child is a complex response, rooted often in instinctive tendencies, but at the same time a logical and inevitable reaction to the general situation confronting him at the moment.

Some characteristics of original nature

It springs from and is due to certain preferential neural pathways. The instinctive equipment of man — often referred to as a part of his original nature — represents the influence exerted upon his behavior by certain pre-connections which exist in the nervous system. These innate bonds may be either already linked up and ready for functioning very shortly after birth — as, for example, is the case with those responses which are concerned with food-taking — or they may remain inoperative until a later stage of the development of the organism, as, for example, is normally the case with those responses which are concerned with sex. Regardless, however, of the time of their full appearing, these inborn tendencies embody the racial heritage of every individual. We cannot avoid the assumption, inasmuch as every person is possessed of substantially the same instinctive urges, that these represent very definite attempts on the part of Nature to equip her children with those fundamental controls and adjustments of conduct which a long racial past has demonstrated to be of importance in the conquest of life. Her one invariable means of thus handing down from age to age the vital experiences of the past lies in so stamping them into the nervous system that their influence must always be felt whenever the conditions are right for their recrudescence.

It represents racial man in the present child. As we stated above, valuable experiences which the unknown ages have brought into the life of the race are carefully preserved by Nature in the nervous system. Were this not the case, each succeeding generation must grope about in blind trial and error for guide-posts and stepping-stones by which to regulate behavior. Nature is, however, too zealous for the ultimate rise and progression of her children to leave it all to chance. Like a good antiquarian she casts about for whatever mementos of the past are worth preserving, and stores them carefully away in her infallible storehouse, the neurone; within its fastnesses are the faint and often undecipherable memorials of a mighty and primitive age wherein the urge of restless activity, necessitous but exhilarating change, zealous amassing and anxious possessing, wild approbation and tyrannical mastery, paralyzing foreboding and eager curiosity — along with numerous other primal impulsions — meant survival and comfort for the individual and his group. What wonder, in the light thrown upon them by these racial origins and evolutions, that the innate tendencies of Nature's child — the inevitable ontogenetic product of cumulative ages of phyletic accretions — are found by every teacher and every parent to be strong and insatiable! In the child's nervous system are emblazoned all the diverse records of the century-old struggle for survival. And that is why children crave activity, adventure, possession, companionship, and all the rest.

It does not reveal itself in its entirety at birth. Only a small portion of the child's original nature is apparent in infancy. Nature holds in reserve much for later stages, revealing at first only such inner impulsions as can find expression and satisfaction through the present sharply restricted possibilities of the organism. When one has ministered to the infant's physical wants and provided it with simple, animated objective experience, he has pretty much exhausted its range of expression. There ensues a stage shortly, however, wherein new inner forces make clamoring appearance and demand satisfaction. Play activities involving gross physical expenditure supersede the earlier restricted and less boisterous play of infancy.

As the horizon is pushed out further and still further from the immediate self, new interests come in to hold sway over the evolving child. The instincts of the herd make their appearance near the beginning of pubescence, accompanied by those of keen rivalry, teasing, ownership, etc. Tardiest of all is the sex urge, faint primordial rumblings of which are felt in earliest childhood, but the full power of which does not manifest itself until the period of adolescence is well entered upon. Thus Nature does not turn the whole force of the racial past into the sluiceways of life at one flood tide; rather, many tides are repeatedly freighted with it, one bearing in its burden, only to ebb gradually and be followed presently by another until at length, after the organism has been properly made ready, the gates are swung wide and the great trust of Nature has been discharged.

The point of chief difficulty with reference to all these instinctive urges is that we do not know very accurately when the time of their appearing approaches, when they are at their zenith, and when they normally begin to wane or to be modified into another form. Thus, for example, we are unable to say exactly when the social instincts are having their genesis in a particular child, and hence the teacher cannot know at precisely what point to make a formal beginning of introducing him to his social heritage. We do know in a general way that these tendencies are very strong in the early adolescent period, and we should change the educational emphasis accordingly at this time. It is true, however, that none of the instincts spring full-grown into existence; they rather go through a somewhat prolonged period of nascence before they become full-fledged, and they pass through a similar period of decadence before they lose their identity in the unfolding individuality. As Strayer and Norsworthy remark:[1]

> It has always been stated in general psychology that instincts are transitory, that therefore it was the business of teachers to strike while the iron was hot, to seize the wave of interest or response at its crest before the ebb had begun. There was supposed to be a "happy moment for fixing in children skill in drawing, for making collections in natural history," for developing the appreciative emotions, for training the social instinct, or the memory or the imagination. Children are supposed to be interested and attracted by novelty, rhythm, and movement — to be creatures of play and imagination, and to become different merely as a matter of the transitoriness of these tendencies due to growth. When the activities of the adult and child are analyzed to see what tendencies have really passed, are transitory, it is difficult to find any that have disappeared. True, they have changed their form . . . but change the surroundings a little and the tendency appears. Free the adult from the restraints of his ordinary life and turn him out for a holiday and the childish tendencies of interest in novelty and the mysterious, in physical prowess and adventure and play, all make their appearance. In how many adults does the collecting instinct still persist, and the instinct of personal rivalry? In how many has the crude desire for material

---

[1] *How to Teach*, pp. 19–20.

ownership or the impulse to punish an affront by physical attack died out?

It is modifiable. Animals, as we pointed out above, are creatures of almost pure instinct. The original nature with which they are endowed remains throughout their entire lives the sole guiding and activating force. By its dictates they secure food, prepare shelter, and perpetuate themselves in their offspring. There is no probability, so far as we know, that they are able to reflect upon a situation, and consciously to choose what their response to it shall be. Maturity for the animal means only the complete ripening and perfecting of its original nature, the difference between animal infancy and animal maturity being merely one of degree, not of kind.

Original nature also supplies much of the inner urging and motivation by which the human being governs his behavior, without, however, limiting him to the animal level of domination by it; and herein lies the explanation of the supreme difference between the human and the animal. The one is enslaved by instinct; the other possesses a rational intelligence which enables him to order his life on a higher basis. Original tendency in human beings is, in other words, modifiable or redirectable according to the dictates of the will of the reagent. And it is fortunate indeed that such is the case, for were one doomed to remain during his whole lifetime a prey to the dictates of his instincts, civilized society would be impossible. Many of the instincts are purely selfish and purely individualistic. Only in a state of barbarism or low primitive social organization can individuals thus dominated live their lives: the very foundations of civilized society rest amid the virtues of altruism, forbearance, and self-control, none of which constitutes a part of original nature, but all of which have to be grafted upon it and carefully nurtured.

Methods of modifying original nature

Punishment. One of the commonly employed but unfortunately less efficacious methods of pruning the shoots of original nature is that of punishing the child whenever it allows its instincts improper expression, as judged by the adult standards or opinions of conduct. This method proposes to correct a retrograde tendency by providing that in the mind of the victim pain shall be associated with the response whenever it occurs. Thus, a frequent means of discouraging idleness in school children is holding more or less continually over their heads the certainty that if they are not industrious they will be compelled to "stay after school" and do their work then. The painful association is thus intended to be built up between "idleness" and "staying after school." The danger is, however, that the child will form the wrong association. The writer was once a small pupil in a school where this was the one and only accepted method of punishment for idleness, mischievousness, and all other misdemeanors. The "work" ordinarily provided was copying a page from the dictionary. The painful association in these circumstances was always between "being kept after school" and "the old dictionary" — which hardly tended to arouse a naturally smouldering passion for that ponderous volume into any very lively flame.

The method of punishment is often efficacious, however, when all others fail. For the positively unruly or antisocial child, "sparing the whip" may indeed result in spoiling. The fact remains, however, that when wrong conduct is disciplined in this manner, an unfortunate fundamental connection may be disrupted without some other compensating connection being fostered in its place. Punishment is therefore ordinarily thought of as a negative rather than a positive method of modifying the child's behavior.

Disuse. Connections that are never formed in the nervous system, or that have atrophied because of lack of proper opportunity to function, will not have to be broken. That method which seeks to discipline and control child behavior by keeping from the child situations that might be expected to provoke undesirable responses is known as the method of disuse. Thus, the unfortunate conviction in the hearts of not a few timorous parents that their children will be led astray in some fashion or other, if they are permitted to mingle promiscuously with other children, leads many to keep them behind closed doors or closed gates during the greater part of childhood and early youth. Thus, such unhappy traits as boisterousness, roughness, profanity, etc., will not be implanted in them because no wrong examples will be afforded them.

The fact that the children disciplined by the method of disuse are not likely to offer resistance or react angrily to it commends it in the eyes of many, but inasmuch as we have so little exact knowledge as to when a given instinctive tendency is likely to manifest itself, and hence cannot be sure when experiences related to it should be kept from the child, we are likely to do more harm than good by resorting to this method, and attempting to manipulate blindly — Rousseau like — the environmental forces that normally would play upon him. This is not, of course, denying the unquestionable wisdom of guarding the unfolding mind of the child against any premature or unworthy experience which might result in moral hurt, or which might lead to morbid imaginings and brooding.

Substitution. By far the most satisfactory method of aiding the child to adjust his inner nature to the essential demands of social living is that which seeks neither to check by punishment nor to inhibit by disuse, but rather to encourage by redirection or substitution. The boy who, for example, is in danger of making himself obnoxious because of overweening pride in the fortunate possession of toys that are better and more numerous than those belonging to the other children in the neighborhood, needs but a little wise teaching to lead him to appreciate his greater obligation to the less fortunate because of his greater opportunity. From tending in an unsocial direction, he becomes, presto! the very finest kind of a philanthropist in boy-land. So with such an undesirable tendency as the gang instinct, on the verge of degenerating into rowdyism: give the rowdies attractive quarters, and something worth while to do with themselves, and you have started them well on the road to good moral and social citizenship. Punish them for being rowdies, or keep them from becoming acquainted — and so deprive them of any opportunities in the direction of rowdyism — and you have still done nothing positive to train them along desirable lines. Can you not think of numerous other illustrations of the same sort?

The method of substitution consists essentially, then, either in replacing something good for something bad, or in redirecting something likely to prove harmful toward something that is individually and socially beneficial. As such, it is in line with the very highest and finest philosophy of human life which, at its best, seeks ever after nobler expression.

QUESTIONS AND PROBLEMS

1. Look up a complete list of the instincts, and at least one common classification of them. Determine which of them, if any, have relatively no bearing upon the schoolroom situation.
2. Is it likely that a child who is constantly held to work that is uninteresting to him may develop in consequence unfortunate intellectual and moral habits and attitudes? Explain.
3. How has modern psychology shifted the center of the school's efforts from subject-matter to the child?
4. Write up as fully as possible the salient features of some lesson you have recently observed in the practice school, making special mention of any attempt on the teacher's part to take advantage of the "instinctive urge."
5. Enumerate instances personally known or observed by you in which original undesirable tendencies have been modified by one or another of the three methods described in Lesson 1.

SELECTED REFERENCES

1. Colvin, S. S. *The Learning Process*, chapter 3.
2. Strayer, G. D., and Norsworthy, N. *How to Teach*, chapter 2.
3. Strong, E. K. *Introductory Psychology for Teachers*, Lessons 32, 33, 34.
4. Thorndike, E. L. *Educational Psychology*. Vol. I, *The Original Nature of Man*. (General reference.)

[illegible]

[illegible]

[illegible]

LESSON 2

THE SIGNIFICANCE OF MOTIVATION

Importance of motivation in human behavior. Human beings never *do* anything without a motive. If I observe Jones to be hurrying in the direction of the city, I may be very certain indeed that Jones has a *motive*, a *reason*, both for going in haste and for going towards the city. Again, if I see Jones strolling leisurely in the country on a warm summer afternoon, I may easily guess the motive which impels him. Or again, if I notice Jones mowing his lawn or trimming his hedge, or chatting with a passer-by, or watching an oriole hang its nest from a bough of his cherry tree, or reading his evening paper, or whistling a tune, or sitting lost in thought, or in any other situation imaginable, I may be confident that he is thus occupied because of some actuating motive which may or may not be apparent to me.

It is true, not all motives have the same foundation or strength. We may think of motives in general as classifiable into three categories: selfish, unselfish, and mixed. Selfish motives are obviously motives that impel one to act for his own sake, or in his own interest, while unselfish motives are such as prompt one to do this or that for others' sake or in the interest of others. In not a few cases the motives behind an action are both selfish and unselfish; in such circumstances, we may think of them as mixed. When, for example, Jones shifts the position of his piazza-chair in order that the slanting sun may not fall upon his paper, the motive is purely a selfish one, resulting in greater comfort and satisfaction for Jones. When, however, I find Jones leaping in front of a plunging team to snatch a neighbor's child from danger's path I do not hesitate to ascribe to his behavior a motive that is quite the reverse of selfish, resulting as it does in discomfort for Jones and comfort for his neighbor. Again, when Jones consents to address the local improvement society upon some issue of neighborhood weal, it is likely that I shall ascribe to his action mixed motives of selfishness and unselfishness.

If you were to attempt to classify the motives back of each of your hundreds of responses during any single day you would find them to fall easily enough within one or another of these three groups — with doubtless the greatest number coming within the caption labelled "selfish." No matter how insignificant the response, or how apparently valueless and irrelevant it was to the real work of your day, it had a cause for occurring.

The bearing of motivation upon the schoolroom situation. To the truth above stated, it is an easy corollary that every response made in the schoolroom has some sort of motivation back of it. If we were to attempt to enumerate all possible children's motives for participating in the routine of the schoolroom, we should discover the following to be among the most common: (1) to excel another; (2) to be promoted; (3) to please the teacher or the parent; (4) to help one's side win; (5) to learn; (6) to avoid punishment; (7) to be excused early, or released from some task; (8) to construct or do something well; (9) to enjoy a process; (10) to maintain social approval; (11) to win a prize or honor. Some of these simple childish motives are selfish, some are unselfish; some are mixed; some of them are positive, some are negative; some are more characteristic of one child, some of another; some are natural and spontaneous, some are artificial and derived; some are worthy, some are unworthy; all are commonly met with in schoolrooms of all grades and types.

The bearing of the instincts upon schoolroom motivation. Since, then, every task of the schoolroom must be motivated in some way or another, and since, as we have noted before, the instincts are in themselves nature's own original method of motivation, the question naturally arises: Cannot the classroom capitalize this instinctive driving force that exists in the breast of every normal boy and girl and so add to the educative process the interest and enthusiasm which go with the satisfying of inner impulsions? The answer is: By all means this can be done, and our best teachers are studying hard every day to bring such a situation to pass in connection with their teaching, as the following instances of well-motivated class work will show.

As you read these accounts by live teachers of how they have succeeded in making the tasks of the schoolroom not only valuable but at the same time intensely interesting to their pupils, bear in mind the instinctive urge in boys and girls of the ages mentioned and try to think how well the projects described must have succeeded in satisfying that urge.

An illustration from the eighth grade.[1] The first example is taken from an elementary-school project.

> The building of a miniature Panama Canal grew out of the eighth-grade class work in commercial and industrial geography. The group comprised thirty-five pupils, ranging in age from thirteen to seventeen years. An engineering staff was selected to assume general charge of construction and planning. Instructions were brief and simple: a working plan must be drawn to scale and the model constructed according to the plans. The choice of a suitable scale was a problem in itself, and eventually three were found necessary, one for the vertical plane, one for the horizontal and, in order that the completed model might function properly, a third for the locks. Profile and "bird's-eye" maps were drawn upon the blackboard. A special table twelve feet long was built for the exhibit. Sand was used for laying out the landscape, modeled after the blackboard plans. Next came the problem of making the canal, the lakes and the oceans hold water. Manual arts clay was tried and found unsuitable. Concrete work was considered but given up. Finally, parowax proved an adequate water-proofing substance when applied to the moist clay, and held

---

[1] Excerpted from "The Panama Canal: An Eighth-Grade Project," by Worth McClure and Emma D. Stone, of the Gatewood School, Seattle, Washington. In *The Elementary School Journal*, vol. xxi, no. 8. (April, 1921.)

twenty-five gallons of bounding main in its proper place! Before the locks themselves were started, a trip was taken to the Lake Washington canal for the purpose of studying real locks in operation.

The first set of locks finally built proved a dismal failure, owing to the fact that the water loosened the cement on the rubber gate hinges and the vertical edges where they met in closing. It was also discovered that despite the application of several packages of parowax, the bed of the canal and lakes still leaked. The engineers tested out new expedients. Woolen felt was ultimately found to be superior to rubber on the locks, while to meet the leak problem troughs were devised and set up in the proper places under the lakes and the seas to conduct the seepage safely into the drain bucket. It was discovered, when testing day came, that the water discharged into the ocean from the locks, automatically taken care of at Panama, must, owing to the smallness of the model, have some supplementary receptacle. A waste-pipe was therefore inserted in the rim of the Atlantic Ocean and another in the Pacific. These pipes led by a small gas hose into the drain bucket.

After the topographical features had all been carefully modeled, according to the blackboard plans, several essential improvements suggested themselves. Among these were the item of vegetation, the provision of real boats for demonstration puposes, the coloring of the water to the requisite blue of the tropics, and the drawing of a map of the isthmus whereby it could be easily explained why the east end of the canal empties into the Pacific instead of the Atlantic Ocean.

Considerable time was spent by the seven girls in the research into the vegetation of the Canal Zone, after which the covering of hills and vales with appropriate verdure was begun. For palm trees, *Equisetum* in vegetative stage was found to be a fairly accurate substitute; madrona twigs served for rubber trees; several varieties of moss from the deep woods represented overhanging growths on the shore of Gatun Lake; grass tufts represented pineapple plantations.

The provision of real boats for towing through the locks — as well as the actual means of towing — were highly fascinating problems. Several diminutive models of ocean liners were constructed, painted with care, and provided with anchor equipment. The "electric mules" of the Canal Zone were reluctantly omitted on account of the time and materials required for construction, and a simple towing device was used. Innumerable problems continually suggested themselves up to the very last day of the year, and it appeared that the daily discovery of new challenges like these made the interest increase constantly.

The initial demonstration was given to the pupils of the room only. Entirely without direction from the teacher, the four engineers apportioned the information which they had gathered or which had been given to them by other pupils, and presented it in four "speeches." These covered the following topics: the history of the canal; the geography of the Canal Zone; operation of the canal; and the passage of the locks. The girls took turns in describing the vegetation. The pupils had been accustomed to socialized recitations, and were consequently well practiced in topical discussion. Any inaccurate statement from a speaker brought prompt correction at the conclusion of his speech.

The fame of the project, of course, grew, and other rooms made requests to be permitted to attend a demonstration. Finally, arrangements were made for the entire school, group by group, to witness a demonstration of the fascinating project. Interest and pride in the achievement were intense.

Why was the project well motivated? An interesting and worth-while piece of work in geography, to say the least! What was there in the project, after all, that made it so appealing to the eighth-grade boys and girls that, as the teacher states, they were at work many a morning by eight o'clock, and many an afternoon were still busy at five, and in not a few cases had actually to be sent home? Fancy children in their early teens being sent home from school for over-zealousness! It is true, they were given to understand at the outset that all formal lessons were to be prepared as usual, and that any delinquency therein was to be made good, regardless of whether due to over-devotion to the project or not. Hence most of the work had to be done outside of school sessions. But the very fact of their continued eagerness and zeal in the performance is sufficient evidence of the appeal which the task made to the children. Apparently there was strong motivation back of it all.

In the first place, the carrying-out of the project gave the

[illegible]

children opportunity for a large amount of physical activity which, as we know, appeals to boys and girls. It was not a matter of mental exercise over a sentence or two — and perhaps a picture — in a textbook; it was rather a matter of the actual investigating of sources and facts, securing materials, choosing and rejecting; putting together and improving upon — always with the end of a completed, tangible and demonstrable product in view. The hand became a co-worker with the brain, and when an educational situation leads to this happy alliance of powers it is not far removed from the pedagogic ideal. Under stress of such a situation the schoolroom becomes less *instructive* on the part of the teacher, and more *constructive* on the part of the children.

In the second place, the canal project (as all projects should) challenged the originality, the resourcefulness, and the ingenuity of the pupils. It supplied them with many a concrete, definite problem, a happy solution of which was essential to the continued prosecution and eventually successful outcome of the whole task. The mere passive study of the details and working of the Panama Canal from a school textbook could hardly result in the arousal of any such capacities as these in the schoolroom life of the pupils. Appeal to the inventiveness and resourcefulness of an individual and you will find him ready and eager to participate in whatever problem is presented.

Third, closely allied with and in a sense growing out of the exercise of one's ingenuity is the pride that comes from successful achievement, anticipation of which smooths over many a seemingly insuperable obstacle and keeps the fires of earnest effort brightly glowing. Can you imagine any greater intellectual or moral happiness than that occasioned by these childish builders of a Panama Canal and demonstrators of its mysteries? Doubtful, indeed, is it whether General Goethals himself derived any greater satisfaction when he finally viewed the mature fruits of his labors in the Canal Zone than did these youthful laborers who in a measure thought his thoughts and builded his conceptions after him.

Finally, fourth, the project united the pupils in a community of effort that would have been hardly possible in any textbook study of the topic. Everybody had some vital bit to contribute to its final successful outcome. At the same time everybody had in mind the problems of everybody else, and was thus made alert to all phases of the common task. There is valuable training for the best things in future citizenship in such schoolroom occupations as these. Could all the perplexing problems of democracy be worked out with the concentrated earnestness of purpose and with the fixed determination of actually making headway toward an ultimate satisfactory solution that attended the efforts of these junior citizens in an eighth-grade democracy, how fortunate for our Country!

Motivating general science in the high school. In the following paragraphs are reviewed some vital methods of making the work in high-school science[1] similarly intensely interesting, as well as of fullest value to the pupils.

A prominent aim in the development of general science courses is to foster appreciation; to keep alive the sacred spark of wonder in the child's mind, not by dogmatic instruction on trivial things, but by realistic demonstrations of a few of the wonderful scientific contributions to human welfare. During the past year the science clubs gave a musical concert by the wireless telephone to the entire school. They set up an arc receiving set and listened to the international news coming direct from the P. O. L. station at Nauen, Germany. A miniature lighting plant was constructed. This included a water turbine attached to the faucet, a small K. and D. generator, a central power plant with fuses and rheostat, line wires on small poles, transformer, and a house model with switches, meter, fuse blocks and miniature electric lamps. Other projects included the construction of a small gas plant, taking pictures and developing them, fire kindling contests, operating gasoline and steam engines, and the study of stars and constellations at night.

---

[1] Excerpted from "Methods for Vitalizing the Study and Teaching of General Science," by J. Richard Lunt, of the English High School, Boston, Massachusetts. In the *General Science Quarterly*, vol. v, no. 4. (May, 1921.)

The most wonderful opportunities of general science may be realized through the methods it offers. At English High School we have developed what we call the Social Experimental Methods. The boys themselves take turns in demonstrating experiments before the class. The amount of interest and enthusiasm aroused is remarkable. It is difficult to keep the boys in their seats. In fact, we make no attempt to do so. We let them crowd around the demonstration to watch what is going on. Pedantic and artificial rules of classroom decorum are cast aside. Instead we have a group of eager young scientists trying to discover some of the great natural laws governing their own welfare, the teacher of course constantly giving directions and cautions. This method assures 100 per cent attention and participation. The entire class is watching and thinking. Nor is this thinking imitative. It is creative — the thinking of an inventor. With proper psychological development the pupil will grasp for himself many of the laws and principles of natural phenomena with no explanation from the teacher. It becomes the duty of the instructor to mold and shape the unspoiled attitude of childhood, marked as it is by ardent curiosity, fertile imagination, and love of experimental inquiry. The method is essentially democratic. Every pupil is given an equal opportunity to participate. This leads to self-activity, develops initiative, and fosters the habits of careful observation and reasoning.

When the home projects, of which each pupil is required to carry out several, are completed they are submitted in the form of pamphlets or small booklets. Special credit is given for neatness, arrangement, and originality. The class experiments are also carefully written up. Here especially the pupil's interest is kept up by the goal which is set: to compile an original science book of his own. All the papers are kept and returned to the pupil at the end of the year. He arranges them and makes an index. They are then sent to the bindery and bound, similar to a real book. This is presented to the boy as a permanent record of his own achievements. Naturally considerable time and effort are put into the preparation of all written work, and often it is attended with elaborate drawings and sketchings and detailed descriptions.

Each science class is organized into a club, with officers and weekly business meetings. We consider these clubs of great value in helping to foster a true spirit of democracy and coöperation and in leading to an appreciation of the responsibilities of self-government. During the present year the science clubs have offered prizes for Boy Scouts contests, original demonstrations, and best books. They gave a musical concert by wireless telephone to the whole school. They presented a gasoline engine with full equipment to the science department.

When general science functions in service to the home and community its greatest value is accomplished. Specialized science training has failed in this important mission. The minds of children have been filled with half-digested formulæ and theories. Page after page of textbooks has been memorized under the guise of learning. The schools must seek not in books but in life those things in science most worth teaching. They must inquire first into the needs of the child, and second into the needs of the community in which the child lives.

The real meaning of motivation in school work. What then, do we mean by *motivation?* Perhaps the simplest answer that could be made would be to say that motivation means *vitalized effort.* This vitalized effort invariably characterizes the attitude of a child toward any task that he undertakes because of its felt relation to his own personal present, past or future experience. As against such an attitude of vitalized effort, witness the attitude of a child toward some artificial task set by the school which has no conceivable bearing whatsoever upon his possible life experiences, but seems merely to have been set for the purpose of "keeping the children occupied." No vitality of effort here! No healthy determination to overcome obstacles and achieve results! Only passive, slave-driven effort that has no positive goal in view, and will spend itself automatically the moment the taskmaster's ever-reminding presence is withdrawn. In such circumstance, the highest motives existent in the children's minds are to perform the set tasks in order, first, to avoid unpleasant criticism by the teacher; and second, to pass with as little delay and friction as possible along the educative pathway — surely not very high and lofty purposes for the breasts of children to harbor!

But real motivation does not lead to either of these reactions. It fires the imagination; it arouses and taps hidden and undreamed-of sources of intellectual energy; it impassions the heart; it releases the flood-gates of determination, ambition, and purpose; it inspires in the child the will to *do*, to achieve, to overcome. And all because the task has been related by a skilled teacher to the actual experiences and circumstances of the lives of her pupils. Nor are the age and maturity of the individual a factor in genuine motivation. It is true, of course, that the kindergarten child is intellectually alive to quite different situations from those which make appeal to the eighth-grade pupil, or the high-school pupil. However, the *response* is invariable in all these cases: given an appealing and meaningful task, related in some positive way to his own experience, the five-year-old will throw as much vital effort into its doing as will the fourteen-year-old. The only important factor in all schoolrooms is that the tasks be psychologically adapted to the maturity and experience of the pupils. The Panama Canal project, described above, would be a poor undertaking to hope to encourage a class of kindergarten or first-grade children to enter upon, much less to expect them of their own accord to select as promising. On the other hand, it is unlikely that junior high-school pupils should give evidence of vital interest and absorption in the rude carpentry or doll-dressing so satisfying to primary children.

The place of the teacher in motivated work. In order to discharge wisely and well her proper functions, a teacher will need to be possessed of three cardinal qualifications. In the first place, she will require to be well versed in the psychology of children of the age of those whom she is teaching. She will find it indispensable to know what are the characteristic instinctive tendencies of the period; in what activities children of such age are peculiarly interested;

what habits are in the formative stage; what attitudes are being evolved; what practices, commonly followed by teachers in these grades, are in danger of being out of harmony with the children; what methods are suggestive as making possible the achievement of maximum results. Cognizant of these and other psychological factors, the teacher will be better able to plan and motivate the work of her school in terms of her children's experience and stage of development.

2) In the second place, the teacher of the type we have in mind will have a clear understanding of what the function of the teacher is. Not to drive unwilling pupils; not to be the only active agent in a school environment wherein the pupils are mere passive recipients; not to compel by motives of fear, nor yet by alluring promise; not to urge nor cajole nor threaten — to teach is to do none of these. To teach is to see broadly and to plan wisely and well; to adapt means to end; to encourage here, to discourage there; to suggest and guide and share; to be learner rather than learned; to inspire and set on fire. Only in so far as she strives to do and be these things is the teacher of to-day worthy of her high calling. Have not you had such a teacher at least once in your elementary-school experience? And have you not perchance also had a teacher of the other type — one who always took the initiative; thought your thoughts before you had the time to; anticipated and smoothed away all your obstacles; planned, executed, and judged all matters pertaining to school and classroom? If you will retrospect a bit you will doubtless recall some one excellent teacher of the former type, and certainly several of the latter.

3) Finally, the modern teacher needs to have as a part of her professional philosophy a clear conception of the nature and goal of the educative process. After all, what is it to educate a child save to train him in initiative, independence, self-reliance, citizenship, and such other traits of intellect and of character as go to make up a life attuned to the

social and spiritual tempo of the age? Modern education is essentially a fitting to live and to live abundantly. It is for adjustment to the social step, yet at the same time it is for the richest, fullest, freest self-realization. If such be the ultimate goal of her work, how indefatigably the teacher who is to initiate all these attitudes and ideals in the rising generation must strive to infuse vigorous life into the curriculum of the schoolroom, to the end that the citizen of to-morrow may be well equipped to fill his place in the world of men! The acid test of her methods will be: in how far does it impel the boys and girls entrusted to her charge to throw themselves unreservedly into the daily tasks?

Two methods of teaching the Revolutionary War. Not so long ago the writer took occasion to look into the methods employed by a certain eighth-grade teacher in teaching the Revolutionary War. Every child had in his possession a copy of a standard textbook in American history. Each day's lesson was assigned in terms of a certain fixed number of pages, determined mathematically by dividing the number of recitation periods available into the total number of pages in the entire book. The teacher was of the " forefinger " type. Now the forefinger method may be described in few words. The teacher stands before the class with the open textbook in her hand, asking specific questions of the children, in order, and receiving specific replies. The forefinger comes into play as her indispensable placemark. She follows down the lines of a paragraph — the while Joseph is reciting his answer to her last question — until another possible query suggests itself, as, for example: " Who was Paul Revere? " to the textual statement: " Paul Revere, a patriot, resolved to find out the British plans." Thence: " What did Paul Revere do after he found out the British plans? " to the textual information that he " rode throughout the night."

In this manner recitation period after recitation period and day after day were spent in upper-grade history, the teacher asking, the children answering in parrot-like glibness. No attempt to interest them in one of the most fascinating and dramatic periods of our Country's story. No endeavor to organize the events of the period around definite and vital problems for individual or group investigation, nor even to outline two or three large topics for orderly and systematic study. Bunker Hill and Valley Forge had no deeper meaning in the minds of these pupils than the mere circumstance of their being connected with the "history class," rather than with the "geography" or the "reading" class. It was little short of pedagogic treason to refer so briefly to and pass over so incidentally the "minute men" of '75. Patrick Henry and James Otis and Samuel Adams remained incarcerated in the textbook. No attempt whatever was made, so far as the writer could observe, to make these thrilling pages of our early history stir the breasts of the children with an appreciation of the wisdom and determination of the founders of these United States. These were merely the dry bones of history, without warmth and will and life!

Fortunately not all teachers fail thus to make the Revolutionary War period vivid and meaningful to eighth-grade pupils, as the following account[1] of a method of teaching the period will indicate.

> When school began this fall the children had at the best but a passive interest in history and geography. In fact there seemed no enthusiasm for any study except literature and composition. How to get them really interested became the problem. One night, while making from the textbook a list of the important events of the war of the Revolution, I had an inspiration. Why not write our own histories and thus make use of the enthusiasm the children already felt for literature to help them become interested in history? We went to work at once. . . .
>
> When we came to the battles of Concord and Lexington, the pupils wrote letters describing the thrilling events of the night

---

[1] Excerpted from an article by Florence W. Watkins, in the *Teachers College Record*, January, 1911.

before, when Paul Revere took his great ride. Into the histories must go pictures of Paul Revere and of his home. So interested were the children in this that then and there we commenced our diaries of the war of the Revolution. In these diaries we wrote anything that a boy or girl imagined would have been written had the writer been living in 1775. Reading from Hart's *Source Books* helped us to get into the spirit of the times. So well did the pupils achieve this that when our principal was reading extracts from some of the diaries she remarked to the teacher: "You or I would not be ashamed to be the author of one of these journals." Several extracts from two of these diaries follow:

"*April 18, 1775.* Much excited by troubles in and around Boston. Crops are sprouting. Built a scarecrow to keep away crows.

"*April 19.* Last night about one o'clock a man came galloping past, yelling, 'To arms! to arms! The British are coming!' My father and I dressed hurriedly, and, taking our guns and all the ammunition at hand, started for the green. There we found many of our neighbors drawn up. We waited a while. Soon the red lines of the British appeared. The major, Pitcairn, ordered us to disperse. We did not. Then he ordered his men to fire. Eight of our men fell dead. Others were wounded. Then we were dispersed. The British went on to Concord where our supplies were stored. There they did little damage. On their return we fired upon them from behind stones and fences. We killed and wounded about three hundred British. We lost 102. I had my head skinned by a bullet. To-night many people have gone to Roxbury and Charlestown, shutting the British in Boston.

"*May 6.* Worked until five o'clock to-day. When I reached home I found father reading a letter from an old friend in Vermont. He is one of the Green Mountain Boys. He wants father to join an expedition to capture Ticonderoga, a fort containing supplies held by the British. Father started with some friends for Rutland to-night."

"*April 18, 1775.* War is certainly coming. We cannot stand things as they are much longer. The men and boys are restless, and the girls wish they might take part in the war.

"I am writing with a tallow stub beside me. It gives little light. It is very late, but I crept out of bed, when everything grew quiet, to write.

"The British are in Boston and are probably waiting their chance to fire on us. They will be surprised at the volley they receive in return.

"We are storing ammunition at towns along the way, but the supply is so small in comparison with that of the British that . . .

"*April 19, 1775.* I am so excited that I can hardly write. I might as well tell the story frontwards as backwards, so I will begin.

"Just as I reached 'that' in my diary last night, I heard a great clatter and noise. I opened my window and listened. The noise grew more distinct. I heard the clatter of a horse's hoofs, but above that, ringing clear and true the cry, 'To arms, to arms! The British are coming!' Thrills ran through me. It seemed as though the time had come to fight at last. The sounds of the horse and horseman died away, but other sounds rose on the air. The people in all of the houses were stirring. Men were getting their muskets and bidding their families good-bye. The boys took their muskets and, with proud looks, went away with their fathers."

Can live motives be supplied for all subjects in the curriculum? No doubt you are saying at this point: "All very well, but it is a much easier matter to supply interesting and even vital motives for such subjects as history and geography than it is for such other curricular subjects as reading, writing, arithmetic, music, composition, and language." To a certain extent we must admit this to be true. It is also true, however, that relatively few teachers thus far have attacked the subjects of the school curriculum with the firm and avowed purpose in mind of relating them definitely to the social experiences of the pupils. By no means have all teachers, even of history and geography, come to the point of studying the motivation of these subjects. While granting, therefore, that it is easier to motivate the study of some subjects than it is others, we are compelled to admit also that thus far relatively little attention has been given by the teaching body and their leaders to the psychology underlying the responses of school children, both to 'history situations' and 'geography situations' as well as to 'writing situations,' 'arithmetic situations,' 'language situations,' etc. In our thoughtless zeal to cover ground we have sacrificed the child to the course of study, and in consequence are in danger of building up elaborate curricula but mediocre citizens. We are likely to be more exercised over the grade attained than with the degree of unfolding of the capacities and abilities of the individual.

It is an encouraging fact, however, that year by year the educational and professional journals are containing more and more reports of successful attempts of the great body of our teachers to infuse into their teaching the life and vitality and appeal that go naturally and necessarily with subject-matter that is thoughtfully related to the social needs and experiences and ideals of boys and girls. You will find it very distinctly to your advantage professionally to begin at once the practice of looking through the standard educational literature, as it appears in your school library month by month, and reviewing carefully the reports of interesting experiments in motivation that teachers are trying out.

Filling a basket with water. Once upon a time — so runs an old fable — a certain king lost a very precious ring down his well. Being desirous of recovering it, he set a hireling to work at the task of drawing up the water, pail by pail, and pouring it into a reed basket. After a few moments at what appeared to him to be a most stupid and useless employment, the hireling threw down his pail and refused to waste time longer at a performance so utterly aimless and futile. As though a basket could ever be filled with water! Railing at the king, therefore, for his folly and at all the king's dominion for tolerating so stupid a monarch, the hireling stormed out of the palace gate. Others and yet others — so runs the tale — were placed at the fatuous task, only to end speedily by dubbing the king a fool and the task a fool's folly. Finally, however, the monarch was fortunate enough to secure another hireling more docile and obedient than the rest, and he it was who after many an hour's toil poured at length into the basket the last bucketful of water from the well. And there, sure enough, lay the precious ring, sparkling and scintillating in the sunlight!

Did you ever draw water from the well day after day, term after term — the arithmetic well, or the history well, or the geography well, or the grammar well — only to pour it all, as it were, into a basket, without ever coming upon the precious pearl? And if so, did you ever grow a-weary of the educative process which kept you thus pinned down to a series of tasks in the solution of which you had neither interest nor purpose because you saw no connection with nor application to the experiences of life? As we saw in the earlier part of this lesson, the only way in which we can hope to make school work purposefully and vitally interesting is by such clever motivation of it that pupils cannot but feel its connectedness with life as they live it from day to day, or as they observe it to be lived by others from day to day. Whatever cannot be thus in some way connected with actual life and experience will act as an intellectual narcotic to some pupils, and will prove an intellectual stimulant to relatively few.

Limitations as to motivation. It should be borne in mind, however, that to plead for vitalized motivation of school work is not to take the position that the primary aim of the school is to entertain the pupils. It would be quite as absurd to organize the school curriculum from such a point of view as it would be to go to the opposite extreme, and affirm that the prime aim of the school is to bore the pupils. There are several important considerations which we shall have to take into account in order to evaluate rationally the significance of motivation.

In the first place, the children of the same age and grade differ so widely from one another in their likings and tastes that what is interesting and appealing of itself to one may be positively distasteful and even annoying to another. Thus, A may find the arithmetic lesson always attractive, while B may habitually and chronically dislike it. So with history and geography and grammar and all the other subjects. Yet it would hardly be the part of wisdom to excuse B, together with B-minded pupils, from the daily lessons and drill in arithmetic. Motivation may go far to lend interest to subjects to which some pupils are particularly averse, but we are not to conclude that it is (or should be made) a magic wand for mesmerizing the children and transforming the daily lessons by some sleight-of-hand into a pleasing brand of educational confectionery.

2 In the second place, there is undoubtedly no little virtue in applying one's self to the task in hand, regardless of whether or not it chances to fall in with one's individual interests, and that school which fails to allow for the development of concentration, will, and determination through the occasional and even frequent setting of tasks not in themselves interesting, is making a poor attempt indeed to train its pupils for actual participation in life experiences. It is bringing up its children on a diet of milk, and never suffers them to assimilate meat: yet it is meat which they must depend upon largely after school. Do not, then, I beg of you, make the mistake of conceiving educational method as a clever attempt on the part of the teacher to make every situation positively interesting to the child. Think of it rather as an attempt to help the child to build up in himself certain definite skills and attitudes and characters and points of view which will be helpful to him later when he comes to the problem of fitting into the social group. The doctrine of interest will pretty much take care of itself in such a philosophy of education.

3 Finally, in the third place, the child in the primary grades is a wholly different person from the child in the intermediate or upper grades. He is inspired by quite different tendencies, and impelled to action by quite different motives. Hence the sort of motivation which the teacher will find valuable in the one case will be quite different from that which she will find helpful in the other. In general, it may be said that the primary child, in order best to focus his

weak powers upon the task in hand, will require considerably more assistance from the teacher in the form of vitalized motives than will the child of greater intellectual attainments. More and more the necessity for making school work inherently and intrinsically interesting should diminish as one passes up through the school system, so that the high-school pupil ought to be able to stand alone, pedagogically speaking, and actually relish a challenging task. This does not mean that teachers above the primary grades should progressively seek to make their work less interesting; it rather means that, through the strength of past achievements and the urge of present and future necessity, students of high-school age should be assumed to have attained a place in their intellectual evolution where every subject of study — stripped of course of formal, non-functioning content — is felt to contain valuable helps in the common tasks of living, and consequently possesses real attractiveness. Motivation, of course, is not limited to methods of presenting or learning a subject: it is concerned quite as much with the wise readjustment of the content of the subject to the needs or the ideals of the age.

QUESTIONS AND PROBLEMS

1. Formulate as definitely as you can in writing what you consider the aim or aims of education to be. After you have done this, consult Reference I (below), and compare your statement with the educational ideals therein expressed.
2. Is the motivation back of any schoolroom task after all of any particular significance? Is there, in other words, virtue in actually doing the task, whether the motive be vital or non-vital?
3. Is an appeal made by a school task to a particular definite instinct always sufficient to inspire the finest effort in the child? Can you illustrate?
4. Select a current article dealing with a teacher's experience in endeavoring to motivate vitally the work of her class. See especially such periodicals as the *Elementary School Journal*, the *School Review*, the *Teachers College Record*, and the *Journal of Educational Method*, all of which contain interesting and valuable accounts of the experiments

and experiences of actual classroom teachers. Write up your opinion of the article from the viewpoint of motivation.

5. Write out in your own words exactly what you understand by the 'project' method.

SELECTED REFERENCES

1. Charters, W. W. *Methods of Teaching*, chapters 8, 9, 10.
2. Kilpatrick, W. H. *The Project Method.*
3. Wilson, H. B., and G. M. *Motivation of School Work*, chapters 2 and 4.

LESSON 3

MENTAL ATTITUDE: AN IMPORTANT FACTOR IN MOTIVATION

All response the reaction to a situation. In the preceding lesson we were concerned with inquiring into the significance of the term 'motivation.' We found that a lesson may be said to have been motivated when it has been related as closely as possible to the actual life experiences — past, present or future — of the pupils. We cited several illustrations of school work thus vitally motivated. We cautioned ourselves, in passing, that the cardinal aim of motivation is not to entertain the class, but rather to set every individual in it to work with a will upon the task in hand, regardless of what that task may happen to be.

In this lesson, continuing our attention to the matter of skillful motivation of school work, we purpose to make further analysis of it from the viewpoint of its reactions upon the minds of the pupils. Some of the questions we shall be concerned with attempting to answer are: Do the feelings play any appreciable part in the learning process? What is the value of pleasurable accompaniments of the learning process? Of positively disagreeable or annoying accompaniments? What is the effect upon the pupils' minds of a 'colorless' lesson? When a child is studying a lesson, for example in geography, is he doing anything else that is bound to make him a different personality thereafter?

Let us start by recalling to mind that well-known psychological principle which states that one's behavior is conditioned at any given moment upon the nature of the situation with which one is confronted. There must always be a situation, and there must always be a responding individual. In low forms of life stimuli are few and responses simple. In higher forms of life stimuli are numerous and responses are highly complex. The earthworm, for example, burrows in the ground during the day, and comes out only at night to feed and reproduce. A simple, direct, non-modifiable response to the stimuli offered respectively by light and darkness. Contrast with this simplicity of behavior, however, the responses of the connoisseur to the strains of "Adoration" or "Humoreske," or to the variegations of a sunset. Obviously the extremes of response are best in evidence when we draw our illustrations thus from the extremes of the life scale: the earthworm, and the intelligent, reflective human being. But we do not need to seek out such extreme illustrations to make plain the principle of situation and response. Given any situation and a responding reagent, the law at once operates. To the situation rattle, the baby responds by seizing, examining, throwing; to the situation kite, the boy responds by manipulating, flying; to the situation interesting book and idle moment, the youth responds by opening, reading; to the situation ringing doorbell, the householder responds by going, opening, greeting. And so we might continue to make interminable lists of the situations that confront people every day of their lives, and the reactions they are likely to make to them as they occur.

The feeling accompaniment of our responses. But let us look a little more carefully into this phenomenon of situation and response. We say we do this (i.e., respond) in consequence of that (i.e., the situation). The whole process is not, however, so simple as this statement might lead one to think. Suppose, in the case of the ringing-doorbell-situation mentioned in the preceding paragraph, there are the additional factors of an easy chair, an interesting book, and the comforting though perhaps vague anticipation in the mind of the individual of a long, quiet evening by the cheery fire. Now the individual concerned is not a piece of responding mechanism keyed to proceed to the door upon the reception of the doorbell stimulus: he is actuated by very definite and pronounced mental attitudes which play an important rôle in determining the nature and quality of the responses which he makes. There is, in other words, a *feeling* side to his life which must be taken into account in interpreting his responses to situations. The probabilities are that he feels distinct annoyance as he lays aside the book and moves in the direction of the door to investigate the purport of the summons. The situation has, in other words, not only an objective but also a subjective phase.

Let us fancy another situation with which the reverse sort of feeling tone is associated: *satisfaction*, rather than *annoyance*. B, ravenously hungry after a morning's hard work at the office, goes at lunch time to a near-by restaurant. The menu card features roast duck — of all things in the world B's favorite dish. The waiter turns out to be attentive and spry, the table service and appointments attractive, and the duck done to a turn. What wonder that B reacts to the whole situation *pleasurably!* How different his mental attitude from what it would have been had the waiter been slow and forgetful, the appointments unattractive, and the duck appreciably underdone! In the one case, B responds by eating heartily and indulging in pleasant speculations; in the other he would likely have eaten grumblingly — perhaps even have refused to eat at all — and mentally pronounced all manner of malediction upon food, waiter, management, and perchance mankind in general.

Two other feeling situations. Or again, contrast the two following situations and the feeling aspects of the responses which they produce in the individuals concerned.

I leave home in the morning in ample time, as I suppose, to catch my train. I walk briskly in the direction of the dépôt, my attention centered more or less closely upon the day's work before me after reaching my office. I am conscious, among other things, of an important engagement that I have at ten o'clock with a gentleman of prominence who is to confer with me on an important matter. As I pass down the street I exchange greetings with a neighbor or two, stop at a corner to buy a paper, and perhaps pause with other pedestrians a moment to watch an excavation gang, or to glance more sharply at a window display, or to observe some sweet-peas climbing over a trellis. Thus far the feeling accompaniments of my responses have been rather pleasurable than the reverse. But now suddenly, as I cross a street and turn into another, I am dumbfounded at beholding the spectacle of my train already under way and pulling out! Witness now my behavior: I pause for an instant; I exclaim in one breath at the seeming unlikelihood and yet the apparent certainty that it can be *my* train; I make swift calculations upon my chances of swinging on to the last coach by sprinting for it; I sprint; I breathe hard with exertion; I am dimly aware that people are watching me and speculating, like myself, upon my chances; my leg muscles begin to tire; I perspire; I leap with my last ounce of reserve strength to the station platform. Too late! I have lost my train. I take a few steps blindly down the platform in the direction of the rapidly disappearing coach; I wipe the sweat from my forehead and eyes; I pull out my watch and compare it with the clock overhead: it is, for some (to me) totally inexplicable reason, ten minutes slow! I declare emphatically to myself that the clock is wrong. The impossibility of keeping my important engagement begins to assail me. I look once more vainly in the direction of the departing train, wipe away more perspiration, glance again at the clock, pick up my bag, and return home.

In the above analysis of my behavior no particular reference has been made to my *feelings*. It was not necessary: the annoyingness of the whole situation from the instant I discovered the train to be pulling out to the conclusion of my speculations on the station platform — and even beyond that, for it is inconceivable that I forgot the incident during the whole day — is so self-evident that comment is superfluous. If you will compare the feeling phase of my behavior in this situation with that of the behavior of the householder in the ringing-doorbell-situation, above, you will easily trace the similarity of the two, and will have added evidence of the existence of a subjective emotional accompaniment to many of our responses which can best be expressed in the term which we have used in describing it: *annoyance.*

One other illustration of the opposite feeling-state will make clearer the existence of a second emotional accompaniment of many of our responses: *satisfaction.* As you read it, bear in mind the example of the hungry man of affairs at the restaurant, suggested above, and note the similarity of the two situations and their respective feeling responses. Let us suppose you have sat down to a game of chess. Your opponent has in times past been able to checkmate you a half dozen or more times to your checkmating him once, so that you approach this contest with considerable apprehension, mingled with the hopeful anticipation that always characterizes even the poorest player at the outset of a game. For a time there is nothing particularly depressing or exciting as several pawns are given and taken, the while the decks are being cleared for action. Now begins the real warfare. In an unguarded moment your opponent makes a careless move, and you capture a bishop. Flushed with pride you forthwith conceive a brilliant plan of attack to follow up your advantage thus gained. Fortunately your opponent fails quite in detecting your purpose, and lo! you have captured a knight! After some minutes of planning and intercepting on the part both of yourself and your opponent, you see an opportunity of taking the enemy queen by hazarding only a rook and perchance a pawn. Outwardly calm, you take the chance. In the grasp of his surprising ill-fortune, your opponent in a reckless endeavor to protect his remaining knight, leaves his queen poorly guarded. This is the chance upon which you have been hazarding, and in a triumphant moment you dash your rook across the field and capture the enemy queen. With her loss goes the last spark of the confidence of your opponent, and in half a dozen moves you have him checkmated.

How different the increasing annoyance of your companion from your own increasing satisfaction as the game drew to its conclusion. Here were not two human automatons mechanically moving chessmen hither and yon across a chessboard, and one of them finally outdistancing the other: here were rather two people in whom the feelings of annoyance and of satisfaction waxed strong. Your own behavior as you found yourself playing the better game was characterized quite as markedly by the subjective feeling accompaniment of satisfaction as by either the purely intellectual thinking, planning, reasoning, or the objective moving of the men.

The feeling accompaniments of children's responses. Thus far, in our efforts to illustrate the fact that there is always a feeling phase of behavior, we have taken our examples from the world of adults. Let us now ask ourselves this question: Do children in their reactions to the situations confronting them show similar evidence of a feeling side? Merely to ask the question is to answer it emphatically in the affirmative. Witness, by way of illustration, the contented babblings of the infant when it is warm and its wants satisfied; the uncontrollable shrieks of glee of the small boy or girl of three or four at the peek-a-boo game; the penetrating shouts of the 'team' members when one of them knocks a home run; the animated face of the girl whose narrative of some wondrous holiday experience holds her 'set' spellbound; the passionate pride of the boy in the kite that soars higher or rides more lightly than any other in the sky; the eager expectancy on the faces of the children when Santa Claus with all his wondrous trappings appears miraculously in their midst; the cries of delight from the streets when the first moist snow of the season falls; the conscious pride of boy or girl in new and much longed-for possessions, such as a watch, or doll, or pair of skates, or box of tools, or 'pencil-box,' etc.; the sighs of perfect content when dinner is finally ready, or the *Youth's Companion* or *Saint Nicholas* arrives, or the story-teller settles thoughtfully into his chair.

In every one of these situations, the most characteristic subjective phase of the children's reactions is the feeling accompaniment of satisfaction. What dull, stupid children they would be indeed were they not often thus bubbling over with the mirth and enthusiasms which stamp childhood as typically the age of quest after satisfiers.

Still, there are plenty of annoying or disagreeable situations which children not infrequently are called upon to face, just as is the case with grown-ups; among such are the rainy day that means no picnic; the parental bidding to weed industrially in the garden on the very day when some exciting adventure had been planned by the 'fellows'; the pranks and teasings of a notorious bully; the punishments for misdeeds; the injustice of a mate; disappointment over games and contests; the loss of a pet; the wearing out or collapse of a favorite toy; the shortness of days and the swift coming of nights and bedtimes; ridicule of a loftily conceived vision or idea; the disparaging reminder of one's youth and immaturity or inexperience. In these and scores of other situations that are thronging to your mind the annoyers of childhood consist, and it is doubtful whether a child's sensitiveness to such situations and his feeling response to them are any less profound than are those of grown-ups to similar disagreeable situations which confront them.

Is there a neutral feeling zone? Thus far, in discussing the feeling accompaniments of response, we have drawn our illustrations from somewhat extreme situations. It is obvious that the hungry man enjoys a well-cooked dinner, and that the chess-player reacts pleasurably to the game which he is winning; it is likewise evident that the gentleman who has settled himself for a long quiet evening with his favorite author will be vexed at an interruption, and that the commuter hurrying for his train will experience annoyance if he loses it. So, on the one hand, with the team's satisfaction when some one makes a home run; the hilarity of the neighborhood children over the first snow storm; the delight of the boy over a new chest of tools; and, on the other hand, the annoyance over a rainy picnic day; the distress over a period of illness; the anguish caused by belittlement and disparagement. These feeling responses are inevitable.

But what about those innumerable situations, both adult and child, which do not strike so deeply and profoundly into the emotional depths and which, instead of being accompanied by pronounced feeling tones, either of satisfaction or annoyance, appear to be without appreciable feeling reference? To the greater number of visual and auditory impressions, for example, we are totally indifferent. To a somewhat lesser degree, the same thing may be said of olfactory and gustatory stimuli, and of the tactual and kinæsthetic. The organic sensations, however, since they are related so intimately to the physiological status of the body, are probably less often neutral than agreeable or disagreeable. Can you think of illustrations of indifferent impressions from each of the seven sensory gateways?

The answer to our question is not far to seek. There is no indifferent feeling state: one feels either pleasantness or its opposite in every response in which there is any feeling at all. There are, however, indifferent stimuli which through faintness or habituation to them fail to impress the senses sufficiently to arouse the feeling reactions of the individual. The responses to such purely sensory impressions are consequently neutral so far as affective phases are concerned. We may say here, in anticipation of a later paragraph, that situations which fail to arouse the self beyond mere sensory impression and the mildest perceptive consciousness, for that very reason fail to challenge the reactions of the self as a feeling personality, and hence are of no influence in the determination of one's attitude or the development

[illegible]

of his character and intellect. It is only those experiences that penetrate beyond mild, low-grade consciousness to the underlying and fundamental feeling attitudes of the individual that are actually educative.

Do the feelings play any appreciable part in the learning process? In the preceding paragraphs we have been endeavoring to show that every response of the individual to the situations which confront him has a feeling accompaniment, ranging from the most extreme annoyance on the one hand to the most extreme pleasurableness on the other. Theoretically, we should assume the existence of a 'neutral zone' midway between these two extremes; but actually no such zone exists, experiences of faint perceptive appeal failing to arouse the feeling attitude at all.

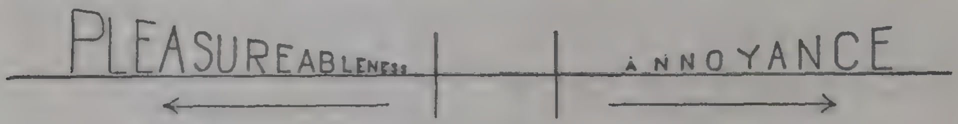


Figure 1. Affection and the Learning Process

Let us now attempt to discover the significance of the feeling attitudes which children manifest in the various schoolroom activities in which they participate every day. More perhaps than any other moulding agency in the life of the child, the schoolroom experience ought to develop initiative, intellectual zest, the spirit of investigativeness, of honest effort, eagerness and determination to achieve, many-sided interests, wholesome standards and ideals, a passion for justice and fair play, and understanding of, belief in, and love for the fundamental tenets of democracy. None of these characteristics and attitudes, so desirable to be built up through the instrumentality of our educational system in the minds and hearts of young people, can result automatically and naturally from schoolroom experiences that are either a matter of indifference or of positive distaste in their effect upon the feeling attitude of the pupil.

From this point of view, motivation of schoolroom tasks in such a way as to make them challenge the child's best effort is seen to be but a question of seeing to it that they make positive appeal to his interests, purposes, and enthusiasms. In the preceding lesson we concluded that motivation is essential in order to get school work done well; in this lesson we can appreciate the indispensableness of motivation as a means of tapping the feeling reservoirs and arousing the personality of the child *on the pleasurable side.* Here is a cardinal principle of education that has too often been lost sight of by educational theorists, course-of-study-makers, and teachers. It is of little use, and may be of distinct harm, to educate a person in the intellectual sense, and in so doing permit his feelings either to slumber or actually to become soured by an educational process which is colorless and neutral half the time and positively disagreeable the other half.

Pleasurable accompaniments of the learning process. Not all children are by nature alike in what constitutes pleasurableness and annoyance in connection with their school experiences. One child may, for example, show a keen and unwavering interest in arithmetic problems, and feel a positive glow of satisfaction in mentally wrestling with them and conquering them, regardless alike of non-motivated teaching and absurdity of problem. Another child, with no mathematical bent, may manifest the exactly opposite spirit, detesting the problems and experiencing extreme annoyance in the daily struggle with them. Such a mental attitude is more likely to be the inevitable product of poor teaching and senseless subject-content than any deficiency in mathematical heredity, although obviously the latter factor cannot be wholly disregarded.

One reason why so many pupils come up haltingly through our grades and leave school at the earliest possible moment that they can legally do so, carrying away with them strong aversions to arithmetic or geography or composition or history, or all of these together, is because the feeling attitude of pleasure, satisfaction, and enjoyment which should have been permitted to find normal and increasing expression from milestone to milestone in their advancement up through the grades, or into a subject, has been stifled through educational bungling, and in its stead the opposite attitude of annoyance, intellectual and affective *ennui*, and even disgust has found ample opportunity of expression. Only those children who have special gifts, or exceptional extra-school stimulation, or strong minds, or a minimum of emotional nature, can be expected to survive and come through the system none the worse for it and even possessed of a determination to go on to the higher school. The other types of children — the moderately endowed, the moderate-willed, the normally emotional cannot adjust to such pedagogic conditions and so, if they survive at all, come through it little the better intellectually and much the poorer affectively and emotionally.

What is needed, therefore, is a school system — i.e., a course of study, a superintendent, a teacher, and an educational philosophy — that will beware of doing violence to the feeling attitudes of young people, and will strive to provide abundant opportunities for their normal development in the form of positive, pleasurable reactions to the schoolroom tasks set for them. This is an essential both for the gifted child and for the mediocre child, for the latter will by such treatment be inspired to the maximum of achievement, and the former will be fired with an enthusiasm and an insight hitherto undreamed of.

A contrast. We can bring out the truth of this matter more vividly by contrasting two series of lessons in arithmetic. As you read the descriptions of each of them, bear in mind the feeling attitudes which the study of arithmetic under such a plan would invariably engender toward it and the general schoolroom situation in the minds of the pupils.

The work assigned to the eighth-grade class[1] involved the borrowing, loaning and investing of money, banking and business practice, square root and mensuration. These lines were pursued vigorously for four days out of each week. On the fifth day a special problem, large enough to continue throughout the term, and directly related to the class work being pursued, was taken up by the class. This problem varied from time to time, but for purposes of illustration the work of buying a lot and building a house is given. Each pupil in the class was expected to select a vacant lot in some part of the city, ascertain the price of the same, and proceed to buy it. Each pupil in the room, or each group of pupils, was given certain limitations. For instance, each pupil in Group 1 was supposed to be twenty-four years old, to be paying fifteen dollars a month rent, to be receiving a salary of fifty dollars a month, and to have one thousand dollars in cash on hand. In buying his lot the pupil was required to pay cash, so that a pupil in Group 1 was compelled to buy a lot not exceeding one thousand dollars in value. Having located his lot and ascertained the price, he secured a legal description, made inquiries as to delinquent taxes and assessments, and finally bought the lot. Deeds were brought into class. Titles were considered. Deeds were recorded and entered for taxation.

---

[1] From *The Motivation of School Work*, by H. B. and G. M. Wilson. Houghton Mifflin Company (1916). 265 pp. Italics in excerpt mine.

Having secured the lot, the pupil began to consider a plan for building. This involved a number of problems. The class considered the cost and advantages of different systems of lighting — lamps, gas, and electricity. They considered different plans of heating — stove, warm air, furnace, and hot water. They figured the expense of the bath. Almost without exception pupils decided to have modern conveniences, including electricity and a self-ventilating system of heating. Each pupil was required to draw and submit a plan of a house, together with an estimate of the cost of building the same. The regular day for this work was Wednesday. It was most common to hear pupils say, 'Oh! I wish Wednesday would come.' There was no lack of interest and the instruction was the equal of that in any other line.

As no pupil had enough money with which to build a house, it became necessary for him to borrow. In studying the question of borrowing money, the different groups were instructed to make inquiry, some of banks, some of building and loan associations, and some of private parties. After the report was made, each pupil was required to make arrangements for the necessary money to complete the building of his house. In securing the loan the property was mortgaged. Mortgage papers were brought to class and explained. Each pupil was required to show that his income was sufficient to pay the interest on his loan, provide for his family, and make some payment each year toward reducing the principal.

As soon as the construction of the house began, it was necessary to secure a fire-insurance policy. This involved a study of property insurance. The amount wanted was determined, the rate ascertained, and the premium computed.

Since the pupil had gone into debt, he was urged to protect his family by taking out life insurance. The amount was left to each pupil, but in no case was it less than the amount of his indebtedness. This insured that, in case of his death, his family would have the property free from debt. The different groups were assigned to investigate different companies. Reports were made on the New York Life, the Mutual Life of New York, and the Equitable. Only the simpler forms of policies were considered — the ordinary life, the twenty-payment life, and the twenty-year endowment. Most pupils took policies under the twenty-payment life plan. Although this work was necessarily made simple, there is no doubt that the pupils appreciate the significance of life insurance both as a protection and as an investment. The completion of the house and the consequent moving in brought this line of work to a successful conclusion.

The teacher who has been handling this work gives abundant testimony to the fact that these problems as taken up from time to time in the eighth grade have been real and vital to the pupils. The pupil appreciates his situation. He is the man of the house. He has a family to support. He is building a home for himself and family. The home is planned very carefully. The house plans submitted have been a credit to the pupils. With scarcely an exception each pupil is *very much interested in his plan*. . . . There are several interesting things about this work. First, the one day each week for four and one-half months is ample time to cover the work very thoroughly. Second, this one day of each week upon practical problems has a wonderful reflex influence upon the regular routine and drill work of the other four days. Tests indicate that there has been steady improvement in the arithmetic work during the last three years, and that this improvement has been due not to more time spent upon the work, but to *greater interest on the part of the pupils*.

The second illustration, afforded by another eighth-grade class in arithmetic frequently observed at its tasks by the writer, offers a rather sharp contrast to the type of work quoted above from Wilson and Wilson.

The work assigned to this class, for a period of approximately eight weeks, was the solution of the 180 general review problems, found toward the end of Milne's *Standard Arithmetic.* The problems on any given page vary considerably in difficulty, but in general they grow progressively harder throughout the twenty pages on which they are found.

Here are some typical problems selected at random:

5. Simplify $1\frac{3}{8} + \frac{5}{4}$ of $\frac{21}{11\frac{2}{5}} - \frac{\frac{5}{6}}{2\frac{1}{2}} \div 2\frac{77}{114}$

30. A, B, and C hire a pasture for \$155. A puts in 20 oxen for $5\frac{1}{2}$ months, B 8 oxen and 28 sheep for 6 months, C 56 sheep for $6\frac{1}{2}$ months. If 2 oxen eat as much as 7 sheep, how much should each man pay?

101. A and B are on opposite sides of a circular pond which is 1380 feet in circumference. They walk around it, starting at the same time and in the same direction. A goes at the rate of 45 yards per minute and B at the rate of 50 yards per minute. In what time will B overtake A, and how many times around the pond will he have traveled?

124. A man spent \$4 more than half his money traveling, one half what he had left and \$2 more for a coat, \$6 more than half the remainder for other clothing, and had \$2 left. How much money had he at first?

134. Which is the heavier, and how much, an ounce of lead or an ounce of gold?

163. A and B invested equal sums in business. A gained a sum equal to 25% of his stock, and B lost \$225. A's money at this time was double that of B's. What amount did each invest?

180. Three men bought a grindstone 20 inches in diameter. How much of the diameter must each grind off so as to share the stone equally, making no allowance for the eye?

In general, the problems involved a review of profit and loss, proportion, square and cube root, mensuration, exchange, money and banking, percentage, factors, interest, longitude and time, etc. There were at least two children in the class who appeared to enjoy the reasoning processes required in the solution of the problems, and whose efforts were never observed to flag during the entire eight weeks, or thereabouts. Aside from these, however, the most naïve observer would have come speedily to the conclusion that the other children found it very hard indeed to put any great concentration upon the problems, and in the majority of cases sat absently biting their pencils, or else gazing idly out of the window, wrinkling their foreheads, and returning with a sigh to the disagreeable book when reprimanded for their inattentiveness. Had there not been such intellectual and affective tragedy in it all, it would have been laughable to note the undeniable relief upon their faces when the period finally ended and recess time came (as it fortunately did at the close of the arithmetic period).

The methods, and the results. What then were the methods employed by the teacher? A product of the old school, she had none save those of the taskmaster. As I watched it all I could not but be reminded of the olden days when the Roman galleys, manned by slaves at the oars, plied the Mediterranean. The schoolroom could easily be imagined the rowing galley, the toiling children the toiling slaves, and the driving teacher the driving master, intent only on keeping the slaves at their work. I rather liked the comparison! She made no attempts whatever to relate the problems in the text to actual situations in the world of men, although in many cases this might easily have been done. So far as I observed, not a single remark was made by her during either class periods or study periods which did not refer specifically and implicitly to one or another of the problems. The aim uppermost in the mind of every child as he approached each successive problem was to get the answer as it was given in the book, and get it through a legitimate process that would bear the critical inspection of the teacher.

When class time came each problem must be copied from his paper upon the blackboard by some child who had succeeded in solving it successfully. Often it chanced that no one in the class had reached a satisfactory solution, in which event several of the best mathematicians among them were sent to the board in a small group to focalize their combined abilities upon the difficulties involved. This was the nearest approach the teacher ever made to actually making the work interesting to the pupils; the stimulus of the group served in such case to challenge the best that was in each, and not infrequently their combined reasoning resulted in a speedy and accurate working out of a problem which had baffled all of them as individuals. The omnipresence of the teacher at their elbows prevented any tendencies toward levity which they might otherwise have shown, and under the spell of necessity concentrated attention, not infrequently accompanied by real interest, resulted.

But what of the other children, those mathematical laggards who made up the great body of the class, and who never succeeded in solving more than two or three of the daily five or six examples? When class time came they were graciously permitted to watch the children at the boards and 'find out their mistakes.' This method had, of course, but one result: instead of doing their best day by day to solve their problems during study time, they dallied with them. It would be so much easier to wait and copy them from the board! In consequence of this absence of any necessity for zealous work they permitted their thoughts during study periods to go wool-gathering, despite the teacher's omnipresence. I believe I never before felt the pedagogic application of the old proverb, "You can drive a horse to water, but you cannot make him drink," as I did on those dreary mornings during which I was a frequent observer of these children at their arithmetic. Day after day, week after week, always the same method on the part of the teacher — always the same attitude on the part of the school. Rarely any moderate interest, never any actual and genuine enthusiasm: always yawnings, frownings, impatient glancings at the clock, scattered attention, slovenly posture. There are no better evidences than these that a lesson is more than half failure.

Colorless lessons. In a preceding paragraph we made the anticipatory statement that situations which fail to arouse the self beyond mere sensory impression and the mildest perceptive consciousness fail to challenge the reactions of the self as a personality, and so are of no influence in the shaping of attitude or the development of character and intellect. We are now in a position to apply this general statement of fact to the classroom lesson. Just as there are some stimuli and some complete situations in the everyday experiences of the individual adult which fail to arouse pleasantness or unpleasantness, so there are similar situations in the school experiences of the child which fail likewise to induce either the one feeling response or the other. In general, as we said, such neutral stimuli in the case of the adult are too faint to challenge feeling or else they are so commonly met with that he has become habituated to them and no longer reacts positively and vigorously toward them. A workman in a chemical plant may, for example, grow so accustomed to the fumes as to give them no thought, while to one unaccustomed to such odors they might and usually do prove highly disagreeable. So with the worker in the noisy factory, or the fireman before the glowing furnace. Adaptation to ordinarily annoying stimuli results in a reduction of the degree of their sensory appeal, and so their feeling appeal, to one of practical indifference.

Did you ever witness or sit under a 'colorless lesson' — a lesson in which there was neither enthusiasm nor interest, on the one hand, nor annoyance nor repugnance on the other? If you have seen such a lesson you know what the author is driving at. The children were passive, lackadaisical, quiescent, torpid. Nothing (save on rare occasions) aroused them to worthy effort; nothing (save on less rare occasions) drove them to despair. They thumbed their books, it is true; they studied, stood, wrote, sat, moved about; they reacted mechanically to the questions of the teacher; they came to school in the morning and went home again at the close of the session. In their classes they listened to the teacher's suggestions, answered when called upon — if they were able; listened humbly to explanations; followed dutifully whatever topic was under consideration; took formal note of the assignment for the next day; and turned to some other study awaiting them when the present recitation was finished. In all of this there was in evidence little feeling — pleasant or otherwise.

Lack of adequate motivation, mistaken methods, confused and confusing aims, a curriculum content poorly selected and ill adapted to the vital human needs and interests of the children — these and other factors were responsible, as they must always and inevitably be, for such colorless lessons. Preparing and reciting (i.e., repeating as *verbatim* as possible) lessons of this order time and time again does but so habituate the pupils to them that they settle down into a state of affective and intellectual torpor from which they are aroused but rarely. It is, in other words, but the old story of the habitual situation resulting in response that is as neutral, so far as feeling is concerned, as it is unstimulating to the intellect. Beware of the colorless lesson: it is as pernicious as the positively disagreeable one!

Feeling by-products of the schoolroom situation. No discussion of the affective side of behavior would be complete without at least brief mention of what we may call the feeling by-products of the educative process. Quite apart from the affective states aroused in connection with the lessons themselves, both in the preparation and subsequent class discussion of them, there are certain accessory feeling attitudes called forth in the pupil while studying or discussing which exert profound influence over him, but whose significance teachers not infrequently fail to appreciate or even sense.

Here, for example, is a boy who is (presumably) engaged in the study of his geography lesson. Apparently after he has mastered his lesson he will be a different boy: his geographical background will be modified; he will have a somewhat broadened apperceptive reference basis as a result of the new information and new point of view represented in the learning of the lesson at hand. But will he be a different boy only in the sense that his geographical concepts have been enlarged? By no means! As he applies himself to the lesson (or refrains from applying himself at all, or applies himself spasmodically) he is forming not only new intellectual conceptions, but new *feeling attitudes*. Thus, in the one case, as he studies he may be developing new interests, new sympathies, new conceptions of service, new ideals of international citizenship, all of which responses to his geography situation are highly tinged with feeling elements of satisfaction; or, in the other case, he may be rebelling against the restraint of the schoolroom, the meaninglessness of the lesson before him, the arbitrary and senseless requirements of courses of study and of teachers, and be confirming himself in attitudes of sloth, deceit, and even hypocrisy which again are associated with strong feeling tone, though of annoying rather than pleasurable nature.

There can be little doubt that these accessory or supplementing feeling attitudes play a tremendous part in the development of the character and the personality of the pupil, combining as they do to produce in him either a saving joy in his work or else more or less pronounced rebellion against it. From this viewpoint, it is not difficult to understand why so many a child comes up through and passes out of our school system 'hating it all.' Attitudes toward school and in a sense toward life itself have been definitely and permanently fashioned from the affective by-products of the educative process.

Professor Kilpatrick, in a recent article,[1] has summarized excellently his conception of the broader significance of education thus:

> . . . I have seen children, after they had passed the history examination, slam their books down and say, "Never again! I hope I may never look into another history as long as I live!" Now it seems to me that our pupils ought not only to learn what was in the history course, but learn also to love history. I have seen older children study their civics and government and come out not caring a rap whether their city was well governed or not. There is something to learn besides what is written in the books, and a child may learn the one without learning the other. . . .
>
> The wider sense of method takes into account the fact that the child inevitably responds to many different aspects of a situation at one and the same time. We need not split hairs as to how many things a person can attend to at once. We know that during the half-hour a boy is facing his grammar lesson, he is not only learning or failing to learn that particular lesson, but he is also fixing or unfixing or failing to fix an attitude toward the subject of grammar, another attitude toward his teacher, another toward schools, another toward himself with reference to grammar and school and his ability and disposition generally. He may be getting interesting suggestions for further study into language when a favorable moment may occur, or he may be hardening his heart on the whole matter. He may be saying, "It's no use. I can't learn anything." He may be deciding that school and parents and the whole tribe of governors are unfeeling tyrants, that wrong to them is right to him, that right to him is success in 'getting by' with his unbridled impulses. . . . In actual life one thing never goes on by itself.

It is highly important that the teacher, from the very outset of her training, appreciate fully the significance of the feeling attitudes in the educative process, and understand that in order to grip the intellect a piece of work must inevitably both appeal to the child's interests and be accompanied and followed by satisfying affective experiences. Otherwise the process may react upon him in a very unfavorable way.

---

[1] From "The Meaning of Method," by Professor William H. Kilpatrick in *The Journal of Educational Method*, September, 1921.

QUESTIONS AND PROBLEMS

1. Recall as accurately as possible instances from your own earlier school days in which positive feeling attitudes, either of pleasure or annoyance, were aroused in connection with some piece of school work.
2. Report upon some lesson that you have observed recently in the practice school, which without any question aroused the interest and even enthusiasm of the children. Try to analyze the teacher's method which was able to secure this positive result.
3. Look up and report upon the 'educational mortality' at the end of the sixth grade; the eighth grade. Is some percentage of this perennial loss accountable to the school's failure to arouse real vivid interests in the minds of the children? In other words, does the great army of leavers each year pass out of the system because they have found the educative process to be an annoying rather than a satisfying experience? What are some other explanations?
4. Cite evidences to show that our educational aims and content are being gradually so modified as to make the school experience of children more pleasurable and satisfying.
5. List other feeling by-products which you have reason to think might be fostered by interesting lessons. By 'colorless lessons.' By disagreeable lessons.
6. Plan an original lesson you would give to some definite grade on any subjects you care to choose. In doing so, bear in mind the principles we have been considering in this lesson.

SELECTED REFERENCES

1. Angell, J. R. *Introduction to Psychology*, chapters 11 and 12.
2. Bagley, W. C. *Educational Values*, chapter 5.
3. Gordon, K. *Educational Psychology*, chapter 15.
4. Strong, E. K. *Introductory Psychology for Teachers*, Bk. 1, Lesson 9.

PART II

THE LEARNING PROCESS

Begin
2 subtest

LESSON 4

SOME GENERAL CONSIDERATIONS

Experiments:

1. *A substitution test.* Study the accompanying figure long enough to understand the general scheme. You will observe that any number may be written in symbols instead of in the ordinary way, once one has grasped the formula. Thus, 1 becomes ┘; 5 becomes □; 8, ⊏; 10, ┘X; 47, ⊔L; etc., etc. Now, after you have the idea well in mind, upon a given signal from the Experimenter (*E*) you, Subject (*S*), are to begin with the symbol for 1 and write as many digit-symbols, in numerical order, as you can in one minute. Continue the experiment through five trials, folding over the paper after each series, so that you will not be able to see what you did in the previous series. Repeat the experiment at successive laboratory periods until you have made at least fifty trials, of one minute each. Preserve your records carefully and we shall learn later how to construct from them a learning curve which will show graphically the progress of your skill in learning a new process. Of course you are not to practice between laboratory periods, with the idea that you will thus make a better record: the purpose of the experiment is not to set up a record nor is it to outdo somebody else; it is rather to demonstrate under carefully controlled conditions the phenomenon of a learning process. Immediately upon the conclusion of each five-series practice, you are to write up in your notebook an analysis of your mental reactions during the series, accounting so far as possible for increases and decreases in the number of symbols written in each minute, due to such controlling factors as fatigue, distractions, interest, annoyance, initial or final spurts, etc.

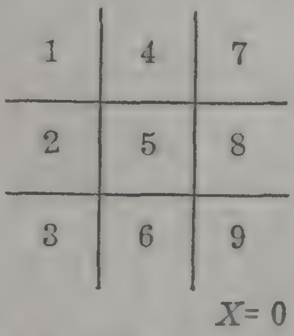


Figure 2. Digit Symbols

2. *A card-sorting test.* Arrange in three rows a series of nine boxes of uniform size and without covers (chalk boxes will do), and number each one conspicuously. The numbers may be plainly printed on bits of cardboard and attached by means of thumb-

tacks to the sides of each box. Arrange the boxes about four inches from each other, being careful that the numerical sequence is broken. Thus, put in the first row boxes 2, 7, 3; in the middle row boxes 5, 1, 9; and in the lowest row boxes 4, 8, and 6. You are to take a pack of numbered cards (similar to "flinch" cards), which have been previously shuffled carefully, and sort them as rapidly as possible into their appropriate boxes according to number, so that at the end of the experiment all the '2' cards will be in box 2, all the '7' cards in box 7, etc. Obviously it makes no difference how many cards there are in the pack so long as they are multiples of nine, and as many '1's' as '2's,' '3's,' etc. *E* will keep a record of the time required to sort the pack. Continue the experiment at one sitting until five records have been made, and repeat the series at four or five or more subsequent laboratory periods, preserving your time records for future use, as in Experiment 1. *E* should see to it that the cards are thoroughly shuffled between each trial, and that the boxes are arranged in the same relative order at each sitting. *S* should write up his introspection immediately after each day's five-trial practice period.

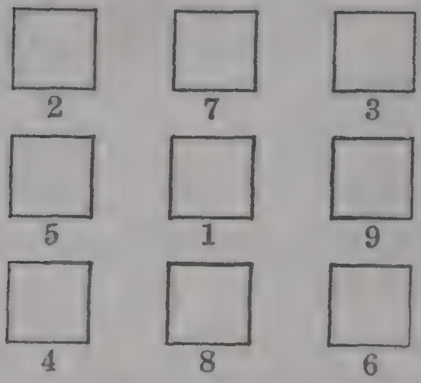


FIGURE 3. CARD-SORTING

What is meant by the learning process?

The aim of the educative process. It is obvious that school buildings, equipment, courses of study, teachers, and all the other educational paraphernalia that go to make up what is commonly termed a school have been brought into existence in order to accomplish something for the good of humanity. In point of money invested, running expenses, and number of workers employed, education is one of the major businesses of the age.

This was by no means always the case. Time was when investments in the business of education were wretchedly small, when the number of workers was a negligible factor, and when indeed the enrollment of pupil-learners was comprised of but relatively few of the whole number of those nominally of school age, according to modern notions. Within the past hundred years, however, most civilized lands have made school attendance obligatory on the part of their youth between certain prescribed ages. Indeed, as uncivilized people advance upwards, under the influence of the march of progress elsewhere, it has been an invariable fact that the attention which they have devoted to the cause of universal education has increased *pari passu* with the raising of the general level of intelligence.

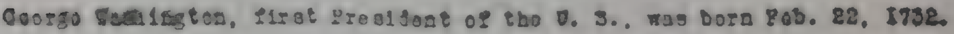
If we ask ourselves exactly what it is that the educative forces thus set in motion by peoples everywhere aim to accomplish, we can find no better answer than that they shall prepare those of the rising generation in every age so to receive and react to the heritage of the past, and so to acquire control over their own capacities that they may be enabled the more cleverly to fit in with the great mass of their contemporaries as imitators or copiers in this and as originators and leaders in that. In other words, the educative process strives to aid the novice to acquire knowledge and skill that he can turn to good account in the coöperative world of men. Nor does the essence of the meaning of education lie in that narrow, utilitarian interpretation of it that views it largely in a bread-and-butter sense; rather it lies in the infinitely broader but still utilitarian interpretation which sees in education a means of stimulating and equipping the individual to prepare for the fullest possible living — industrial, intellectual, family, social, spiritual.

If such be the end and aim of the *educative process*, what must be the nature and characteristics of the *learning process* involved? What is the reaction upon the individual learner? How is his behavior modified by the bringing to bear of the organized and formal educative forces upon him? What are the steps whereby this modification takes place? What factors make for the greatest economy and efficiency of the process? What are the different kinds of learning, and what are the salient features of each? To these and other problems connected with the learning process we are now for a considerable period to turn our attention.

First experience at typewriting. Let us start our study of the process of learning by examining a situation to which the individual reacts more intelligently after he has practiced or experienced it a bit. In so doing we shall be better able to comprehend something of the nature of all learning, for it is obvious that education after all is but a process of multiform learning, and that schools exist for the sole purpose of fostering and hastening and insuring that process.

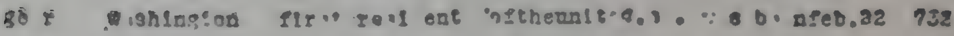
Not long since the writer observed an individual's first actual practice period upon a typewriter. The individual, *S*, was a normal-school senior who had never before even put her fingers upon a typewriter. She did not know how to insert the paper, how to space letters or lines, how to make capital letters, nor how to make any other shifts or adjustments of the machine, nor of course where to look for the individual letters of the keyboard. The instructions were simple. *S* was shown the machine (an Underwood Standard, No. 3) and told to insert a sheet of paper and write as rapidly as she could a sentence which had been previously written on the same machine by the experimenter: The sentence and the result were as follows:

THE COPY



George Washington, first President of the U. S., was born Feb. 22, 1732.

THE RESULT OF S's FIRST PRACTICE



gō r   W shington fir'' re'i ent 'oftheunit'd.) . : e b· nfeb.32 732

When it was evident that *S* understood fully what she was to do, she seated herself comfortably before the typewriter and began to inspect it. Her first difficulty, naturally enough, came when she attempted to insert the paper. It took her precisely two minutes and ten seconds to do this. During all but the last five seconds of this period she simply poked the paper time and time again between the rollers, supposing apparently that it would pass in of itself if started correctly. At length she hit upon the idea that there might be some connection between the rollers and the knobs, in consequence of which she grasped the right-hand knob and turned it gently, but in the wrong direction. Five seconds later she had reversed this process and was being rewarded with seeing the paper appear in its proper position before her. She spent a few seconds trying to tuck the top edge neatly under the holders, but failing in this she began to look for some means of sliding the carriage to the right so that she could start her writing at the left margin, as she had been instructed to do. After trying numerous possibilities, she finally struck the back shifter, whereupon the carriage moved in the wrong direction. Some fifty seconds later she chanced to try the release bar, which she discovered would enable her to move the carriage in either direction at will. After she had the carriage in the desired position, she searched about for "G," which she pressed lightly, producing "g." *S* made no appreciable effort, neither at that point nor at any other time, to find out how to make the capitals. Then followed in order "e-o-r-g-e," the "o" and "g" being, however, so faint as to be barely legible. For sixty-five seconds after the completion of the first word she sought means of spacing, at the end of that time coming back to the release bar, by means of which she spaced two spaces instead of one. "Washington" was spelled correctly, with a small initial letter. The comma after "Washington" was omitted entirely; the fact that it appeared on the same key with a period and a question mark seemed to confuse her. Spacing was accomplished again by the use of the release bar, five spaces being made. "First" and "President" were both spelled correctly, but no space was left between them, and the latter word was begun with a small letter. Double spacing was made after "President," but no spacing at all was done between "of" and "the," and "the" and "United." "United" was spelled with a small initial letter and followed by a period. "S" was "s," with its period a space removed from it. "Was born" and "Feb." were double spaced, and "Feb." was spelled with a small letter. The period after "Feb." was correctly placed, but there was no spacing between it and "22," nor was "22" followed by the comma. For 85 seconds *S* hunted for a "1," but being unable to find any way of making it she omitted it altogether and wrote "7-3-2," omitting the final period at the end of the sentence.

The total time required by *S* in the whole process of inserting and typing was thirteen minutes and five seconds.

How *S* wrote the sentence. Immediately upon completion of the task, *S* wrote out as best she could (having had no previous practice in introspection) a description of her state of mind during the practice period. Here it is:

> My first feeling was one of entire stupefaction. I could not see but one place for the paper to go, yet I could discover no way to get it into that place. After a good deal of fumbling and experimenting with everything that looked promising, I finally found that when the paper was wound on a little it did not come off, so I kept winding. There was some feeling of relief when I came at the actual problem of making the letters, for they were there before me, at least, and after I had struck G and found it on the paper the way looked clear, though I was aware that it should have been a capital letter. I finished George, and then was stopped. The button marked "spacer" would not punch, but nevertheless I felt that I ought to try some other way, with the vague thought flitting through my mind that perhaps the machine was not working properly. (As a matter of fact, this key, marked "back spacer" was working, and would "punch" if punched hard enough!) In experimenting to get the paper in, I had discovered something that shifted the paper, and re-discovering this I was able to shift, although it left peculiar uneven spaces. I left out all commas, but discovered the period in time to get that in. I was completely balked again when I came to the capital in Feb., but could find no way to make an F capital that I dared try. I could also find no 1, but felt sure it was there if I took the time to go over the buttons a second time. I felt angry at my failure to find it the first time and decided to leave it out and get to the end of the sentence as soon as I could. When I finished I felt curiosity to know where some things were and how they worked. I also felt

annoyed because the buttons were not marked so that they could be found more easily.

If now we contrast the typewriting ability of an individual who is skilled in the operation of a machine with that shown by *S*, we shall get a glimpse of the educative process, in so far as it may be typified by learning to typewrite from two angles, the starting-point and the goal of achievement.

The same copy ("George Washington, first President of the U.S., was born Feb. 22, 1732") was given to an expert typist, with the same preliminary instructions, and she was able to reproduce it perfectly upon the sheet in about twenty-four and one half seconds, a saving in time of a great many hundred per cent.

It is, of course, obvious that the educative process is not limited to the development of skills similar to that developed in the typist; education is concerned with the learning of processes of a far more complex sort than mere cleverness with the fingers upon the keyboard of a typewriter. Certain basal principles or conditions, however, must be found to underlie all learning, be it that of typewriting, or memorizing, or problem-solving of the most intricate and involved sort. Hence a study of the process of learning to typewrite is very closely related to the study of any other process of learning, and in *S's* experiment we have an inkling of certain things that characterize any process of acquisition. To these factors we shall now turn, reserving for subsequent lessons a more careful inquiry into the several kinds of learning.

Physiological basis of the learning process. Physiologically speaking, all learning of the habit-inducing sort involves the formation within the neuro-muscular system of certain new *bonds*, or nerve connections. In the case of the expert typist referred to above, for example, the entire neuro-muscular route between the inserting of the paper in the machine and the placing of the period after "1732" was linked up *instantaneously, and relatively without thought.* Old bonds or nerve connections which had functioned together so many times in previous experiences with the typewriter were so well-formed that, like the human voice threading its way along innumerable telephone wires, there was no turning aside. Let us see what some of these connections or bonds were. There were, among others, 'through connections' between all the sensory and motor neurones concerned in inserting the paper properly and in adjusting the carriage; in getting the copy and transferring it to the paper; in spacing, capitalizing and punctuating in the proper places. The mere perception of the copy plus an awareness of what was to be done formed sufficient stimulus to place all these neural connections in a state of readiness to conduct when the appropriate instant came, and to conduct in the most direct, economical, and efficient manner. Aside from vague kinæsthetic images that preceded each group of movements, the operator's mind was relatively inactive, relatively little concentration being necessary during the process. And all this because of definite *habits* formed in previous practice or learning periods which had reduced the process to practically an automatic one.

Bonds or nerve connections illustrated. To illustrate a single one of the series of numerous bonds or nerve connections which functioned automatically, let us take the complete action of inserting the paper and sliding the carriage to the left in order to begin writing. The sheet of paper which the expert had been directed to use lay on the table, just to the left of the machine. She grasped it by the left edge at a point near the top with her left hand, carried it to the proper place of insertion at the back of the machine, grasped the fluttering right side of the sheet with her right thumb and forefinger just as the left edge slipped into position, exerted a slight pressure to insure that the lower edge was in uniform contact with the rollers, darted her right hand down to the right grip and rapidly rolled in the paper, still guiding it with her left hand as it was taken up. When the top of the paper was visible above the liner her right hand, in addition to turning the grip, exerted a pulling pressure; this was supplemented by her left hand, which darted to the left-hand grip and exerted a pushing pressure. Thus the carriage was forced over to the left-hand margin where the writing was to start. The process occupied exactly three and one half seconds. The actual time consumed in reproducing the copy was twenty-one seconds.

The expert typist was asked after the completion of the experiment to write out a description of her feelings during the period. Here it is:

> I felt perfectly comfortable in writing the sentence up to the time I had finished writing "U.S.," but at that point I was a bit uncertain as to whether I ought to put a comma after the S. I did not wish to take time to look back to see whether I had put a comma after Washington, which would have made one after S. necessary, so I simply "took a chance" on putting one in. It developed that I had done the right thing.

The difference between the two operators. By comparison with the expert's, *S's* work is crude and blundering. Wherein lies the difference? Why did *S* consume two minutes and five seconds in poking the paper again and again against the rollers, and finally only hit upon the idea of turning the rollers by chance, while the expert, in half a dozen movements, had the paper inserted absolutely without any hesitation or chance? The answer lies of course in the fact that the latter's neuro-muscular system had in it specific bonds or preferential routes between situation and response. To the situation insert-sheet-in-typewriter, for example, these bonds forthwith brought the response: place-paper-here-and-turn-knob-in-that-direction-as-rapidly-as-possible-at-the-same-time-exerting-pressure-on-the-carriage-to-the-right. To the situation write the copy these inner connections engendered the series of responses concerned with producing the copy, with appropriate spacing, capitalization, and punctuation. Thus, in the case of writing "George," one finger darted to the shift-key, while other fingers flew in time order to e-o-r-g-e. There was no searching after keys, nor was any finger idle. Connection bonds between a desired key and the immediate striking of that key were so strong that the operator might have closed her eyes and have written the copy just as well.

It is, therefore, a peculiarity of our neuro-muscular system that as a result of practice or experience new reactions of the organism may be created or old ones modified. This is a fundamental principle underlying all learning. Were it not so, were the organism's reactions non-modifiable, we should remain creatures of blind instinct, such as characterizes the lower orders of animals. In a later discussion (see Lesson 9) we shall endeavor to analyze various forms of ideational learning. In this introductory lesson, however, we are concerned merely with the enumeration of certain of the general facts and principles which according to our observation underlie processes of learning of the habit-forming type, or, as we have interpreted them above, the formation of neuro-muscular bonds between specific situations and responses.

What are the results of the learning process?

Bearing in mind the typewriting situations referred to above, let us now ask ourselves this question: In consequence of the formation of new bonds between any given situations or series of situations and the response or responses, how is the subsequent behavior of the individual modified when he is confronted with the same situation, and of what value are these new bonds in the control of his subsequent behavior?

A. Nerve routes bonded together become second nature. It goes without saying that whenever a bond is formed in the organism a *habit* results. That is to say, once a neuro-muscular connection has been formed through practice, the subsequent encountering of that situation will tend to cause the organism to react with that particular response. The inevitableness of this tendency to connection will depend ordinarily upon the number of times the neuromuscular mechanism has been linked up in that definite order. If, for example, situation *A* has been one hundred times responded to by response *B*, we may assume that it has become *habitual* for the individual to respond thus to situation *A*, in consequence of which a bond may be said to have been effected between the two. If, on the other hand, situation *A* has been responded to indiscriminately by either response *B*, *C*, or *D*, the sequence is no longer inevitable, since no definite and exclusive bond has been built up between either *B*, *C*, or *D* and *A*. Suppose a person has responded a few hundred times to the situation $8 + 5 =$ by thinking 13; there is every likelihood in the world for inferring that he will always so respond. Or, suppose one has invariably responded to the situation invitation-to-smoke by smoking; inferentially he may be expected to respond thus always. Or again, suppose he has responded an infinitude of times to the situation entering-the-house by removing his hat; we may assume that such response will regularly follow the encountering of such a situation.

However, suppose the second-grader responds to the situation $8 + 5$ by saying 13 on one occasion, 12 on another, and 14 on another. We shall be unable to predict what his response will be on the fourth and the fifth and the tenth occasion of meeting the situation, $8 + 5$. Again, suppose one responds to the situation capital-of-Afghanistan by saying on one occasion Kabul, on another Seoul, and on still another Reykjavik. We are in no position to know what his response will be on subsequent occasions of meeting the situation. Or again, suppose the novice responds to the situation playing high *g* on the violin by playing $g^{\sharp}$, *g* natural, and $f^{\sharp}$ on three successive occasions of practice; we cannot predict what note he will play on subsequent occasions of attempting high *g*. So we might go on to apply this principle of situation-bond-response, or situation bond-in-process-of-formation response, to most if not all the learning processes of life: it would always be found to hold true that under normal conditions an individual responds to a definite and frequently encountered situation in a constant and habitual manner, and that ordinarily the inevitableness of a response is dependent upon the number of times it has been made. Can you think of any exceptions to this principle?

Here, then, is one of the cardinal results of repetition or practice of a given response to a given situation: neural pathways bonded together tend to become second nature. You will recall that the fundamental part of the definition of an instinct is that it is an *inborn* tendency to respond to a definite situation in a definite way. Note the physiological similarity between the situation-bond-response that has been learned by repetition, and the situation-bond-response that is already linked up at birth ready to function when the season is ripe. The latter neural routes have been connected through unknown ages of phyletic repetition, and probably fostered by natural selection; the former have been connected through practice on the individual's own part and fostered by his conscious intelligence. The important thing is that, basally (i.e., physiologically), an unlearned response and a learned response are similar.

An important corollary. A corollary to this principle is of tremendous importance in the economy of our lives. The instinctive, automatic, and other inborn responses are controlled by the lower levels of the central nervous system and by the complementary sympathetic and autonomic systems. The higher levels of associative intelligence and will are not ordinarily concerned with their functioning. This means that the brain exercises no regulating influences over inborn neural connections unless and until it chances to be brought to bear consciously upon them. Similarly, neural routes which have been linked up through habit are released from the direct control of the higher center and placed under the control of the lower centers. In other words, it appears that definite learned responses to definite situations have been reduced functionally to the reflex level of the nervous system.

In consequence of this wise transference of regulative function from the brain to the sub-cortical levels, the former is relieved of much of the work which would be necessitated were every one of our actions maintained under its immediate control. In the typewriting experiment, for example, the expert operator paid little if indeed any attention to the position of the keys and the mechanical operations concerned in reproducing the copy; whatever conscious attention she used was directed principally upon getting and understanding the copy — its punctuation, abbreviations, and capitalization — and was focussed only incidentally upon the mechanical factor of striking keys and spacer, the latter having been reduced to the level of second nature through long practice in manipulation.

So with one's handwriting. How much conscious effort do you expend upon the actual shaping and connecting and aligning of the letters in a word? If you will introspect sometime when you are writing, you will note that these factors are made possible by certain well-defined neuro-muscular habits far below the level of will and concentration. The mind is concerned only in the meaningful sequence of letters and words. The case is no different with the multiplication tables. If you purchase five pounds of sugar at six cents a pound, the amount of brain effort required in figuring out the bill you must pay is negligible. Can you not multiply illustrations of such conscious behavior which is regulated either without any conscious effort at all, or at most with but a modicum of it?

It will be unprofitable at this point to enter into a discussion of higher types of learning in which, due to the relative absence of mechanical factors, previously formed neuro-muscular bonds play little part. We shall however discuss these higher and more strictly intellectual types of learning later, and even in those we shall perhaps find that most of our ideational responses are built up by joining idea to idea or perception, in much the same manner in which a definite habit response is joined to a definite habit-inducing situation.

B. Neural pathways bonded together make for economy of performance. The second result of practice of a series of situations-bonds-responses is an outgrowth of the first. We may interpret economy of any performance in terms of (1) skill, (2) speed, and (3) accuracy. In *S's* first typewriting period the absence of all three of these factors in an economical performance is very noticeable. To require two minutes and ten seconds to insert a sheet of paper in a typewriter, and then nearly eleven minutes to write a single very short sentence of a dozen words, is proof enough of complete lack of *skill* in the performer. So with *speed*. The mere contrasting of *S's* thirteen minutes and five seconds with the expert stenographer's twenty-five seconds in turning out the same piece of work, under the same conditions, is sufficient evidence of the former's relative slowness. The performance took more than thirty times as long as the expert's. On the score of *accuracy* of the transcription, *S* also fared poorly. It is true, she made no errors in striking the letters, but in the matter of spacing, punctuating, and capitalizing she made errors, both of omission and commission.

The truth of this second principle that bonded nerve routes make for economy of performance may be further illustrated from any of the skills that human beings possess as a result of practice. I once watched a railway mail clerk sorting letters. Before him, hanging in rows from supporting frames, were some forty or more mail pouches. On the table beside him were hundreds upon hundreds of the thirty-three million letters and postal cards sent daily through our mail system. As I watched the man sort this enormous mass of material I marveled at the speed and accuracy of his work. As fast as his hands could throw them the letters were dispatched to their appropriate pouches. Never once, during the fifteen minutes that I watched him, did one of the pieces fall between the sacks or beyond them, or in the wrong one, although I estimated the farthest bags to be at least fifteen feet away. Like a skilled machine he tossed a letter here, another one there, and another yonder. The sole limitation by which he was bound was the necessary instant it required to glance at the destination as indicated by the address; once he perceived the destination of a given letter, those finely coördinated and adjusted bonds which connected the neural awareness-of-destination with the muscular movement-toward-bag-going-thither reacted, and barely stopping to look in the direction of the bag he twirled the letter toward it. Skill, speed, and accuracy were all conspicuously present in the performance.

Other illustrations of this second result of practicing a performance may be seen in the receiving and sending of the telegrapher; the playing of the pianist, the violinist, or other instrumentalist; operating power machines; pitching a ball; performing sleight-of-hand tricks; aiming at and approximating a target; cutting to a line; rowing a boat; keeping three balls in the air simultaneously; balancing and guiding a bicycle; skating, skiing, and swimming; and in a very large number of other performances in which skilled neuro-muscular coördinations are a condition of efficiency. By contrasting the initial trials of any one of these arts made by an amateur with the ease and spontaneity which characterize the performance of the connoisseur, one may appreciate the part played by practice or habituation in the economy of performance, remembering that the physiological basis of the skill resulting upon this practice is the bond that has been built up between a specific result to be achieved (situation) and the actual achievement of it (response).

C. Nerve routes bonded together result in a minimum of fatigue from performance. In *S's* initial experience with the typewriter it was very apparent to the observers that she was concentrating the entire force of her consciousness upon the task at which she had been set. Now attention of a forced nature such as this is a very fatiguing process, as you well know if you have ever spent days of apprenticeship at such tasks as learning to typewrite or telegraph. The expert operative is at a decided advantage over the novice in this respect, for she has so reduced the actual operation of her machine to habit levels that her mind is at least intermittently free to think of other things. In one other respect also the inexpert is at a decided disadvantage: she must make so many consciously controlled movements, many of which have to be consciously inhibited just at the point when full muscular release is about to come (as for example when she is in the act of striking the wrong key and 'catches herself' in the nick of time) that the fatigue factor is multiplied many times. If we add to this the discouraging and probably fatiguing effect of states of annoyance — which are distressingly numerous in the initial practice stage of any performance — we shall have a better understanding of the reason for this third result of learning; i.e., the generation of a minimum of fatigue.

The story is told of the city boy who went one summer to visit his cousin in the country. It chanced that the country boy was engaged at the time in helping his father mow out a large fruit orchard in which the trees were so low and so close together that the horses could not be driven in among them, hence the grass must be mown with hand-scythes. Bright and early in the morning the country boy was at work, briskly swinging his scythe as he whistled an accompaniment. Swath after swath lay in neat rows among the trees. Desirous of helping his cousin, and also fascinated with the novelty of mowing grass with a scythe, the city boy shortly afterward appeared, armed with his uncle's scythe.

For a time all went well. True, he knew nothing about swinging a scythe. His windrows were less orderly than his cousin's, and he occasionally ran the point of his scythe into the soft ground; but he kept persistently at the work for some time. At length, however, coming out from behind the end of a fruit shed the country boy was surprised to observe his cousin sitting dejectedly on a pile of grass, opening and shutting his hands and anon bending his arms back and forth at the elbows. Inquiry led to the lad's admission that his muscles were tired and sore from the unfamiliar work, that his back ached, and that his palms were covered with blisters. The country boy, inured to the work, was inclined to smile at his cousin's discomfiture, but down deep he understood, of course, and knew how to sympathize. He himself had swung a scythe so often that attention to the process was no longer necessary; he had, moreover, become so habituated to this kind of work that his neuro-muscular mechanism was not called upon to inhibit clumsy or ill-directed movements. Consequently each successive release of muscular energy was economically timed and regulated so that every movement counted for something, while the fatigue factor was reduced to a minimum. In addition to these points of advantage, the country boy had the added advantage over the city boy of finding it possible to think of many things not directly concerned with his immediate work, and from which no doubt he could actually derive no little pleasure to cheer him on.

Added illustrations of this third result of having learned a series of adjustments may be witnessed in the rapidity with which fatigue sets in in the learner's initial practice of any new or unaccustomed type of performance, and the corresponding relative tardiness with which fatigue develops in the performance of work to which one has become habituated.

D. Nerve routes bonded together result in certain significant subjective changes of attitude in the performer. You will recall from the description given by the expert typist of her state of mind during the transcription of the copy given her these introductory words: "I felt perfectly comfortable in writing the sentence. . . ." The expert was not a skilled introspectionist, and consequently made no attempt to describe the structure of her 'feeling of comfortableness,' but that is an insignificant matter for our present purpose. The fact that she took pains to characterize her general feeling state as one of 'comfortableness' is the important thing. If she had been pressed to analyze this feeling, she would have explained that she had no presentiments of anxiety or doubt as to her ability to write the copy accurately, no fear of being unable to locate keys or adjustments; in a word, no embarrassment due to unfamiliarity with the task. Her 'comfortableness' was born of the awareness of skill in manipulation, and the certainty of turning out an acceptable product.

Contrast with her state of mind that of inexpert *S*, who had no such assurances as these and whose skeptical expectancy was little more than certainty of a poor product and an all-round poor exhibition in the process. Her expression and gestures reflected continually more or less this state of mind. She scowled, knitted her brows, shook her head by turns. More than once she sighed disgustedly. Occasionally she ejaculated in annoyance. In the sense of the meaning of 'comfortableness' as used by the expert, *S's* feeling would be precisely one of 'uncomfortableness,' with a maximum of anxiety and embarrassment and with complete lack of awareness of dexterity.

All this is but saying that neural routes bonded together through practice result in certain changes in the psychology of the performer that are of no little significance in subsequent practice. The most basic aspect of these modifications is perhaps the confidence which comes about from practice. This confidence after all is but the psychological aspect of a process in which skill through practice has finally been achieved. It inheres in the expert in any line of neuro-muscular cleverness. The 'fancy' skater, the accomplished pianist, the expert penman, the 'star' pitcher, the clever magician, the 'crack' shot, the exhibition dancer, the 'champion' wrestler, the daring ring performer — all are obviously possessed of confidence in their ability to reproduce at will the acts or series of acts in which they have acquired proficiency. And yet only the expert in any of these lines appreciates fully the discouragement and often despair which long precede the attainment of the state of confidence or 'comfortableness' that is ultimately arrived at.

The learning process a never-ending process. Allied with this confidence, which results from long-continued and successful practice, is at least one other psychological factor of considerable significance in subsequent performance. Confidence sweeps aside all barriers, and the learner, as he finds this confidence developing, gains new visions of his possibilities, and new ideals of achievement in the line of activity that he is pursuing. Few indeed are the so-called 'experts' in anything who have reached the maximum of their capacities, and this holds true of neuro-muscular performance no more than of more strictly intellectual performance. The difference between a 'hack' workman and a growing, developing workman, in any line, is often the difference between one who has lost visions and ideals (if indeed he ever possessed them) and ceased to strive toward better things, and one who is constantly dreaming dreams of greater attainment and working incessantly to bring them to pass. Looked at from this standpoint, the learning process is seen to be a never-ending process. For most of us in any field of endeavor there are always likely to be new short cuts, new combinations, and new adjustments which can be made and which, once found, often become the bases for newer and wider learning and so of greater achievement. The case of the magician who, having learned to keep two balls in the air, forthwith conceives the notion of keeping three in the air, and then four, and even five, is a case in point. The only limiting factor in this and in like performances is obviously a physiological one.

In the higher realms of intellectual conquest, we may typify this same principle by the persistent efforts of novelist, artist, and poet to express themselves in ever nicer conceptions. And in our own profession of teaching, where should we be but for the constant urge of our innermost souls to newer and higher ideals of work and of service? As with any other artisan, so with the teacher-artisan: the 'hack' and the persistent idealist grow daily further and further apart as the latter strives toward higher levels.

The sentiment of Holmes can apply no more aptly to any kind of learning process than to the lifetime learning process of the teacher-artisan:

> "Build thee more stately mansions, O my soul,
> As the swift seasons roll!
> Leave thy low-vaulted past!
> Let each new temple, nobler than the last,
> Shut thee from heaven with a dome more vast,
> Till thou at length art free,
> Leaving thine outgrown shell by life's unresting sea!"

QUESTIONS AND PROBLEMS

1. In this lesson we have been discussing primarily only learning of the habit-forming type, and have referred but incidentally to the other types of learning the end of which is acquiring or using knowledge, and which we may term *ideational learning*. In what ways, if any, are the processes of forming a habit and acquiring a bit of knowledge identical? In what important respects do they differ? (See Ref. 2, below.)
2. Can you justify the statement made in the text to the effect that for the progressive individual the learning process is likely to be a never-ending process? Of which type of learning mentioned in 1, above, is this more likely to be the case? Why?
3. In this lesson we have been discussing certain valuable results of the habit-forming process. It is true, on the other hand, that the human tendency to form habits may make for stagnation and 'old fogyism.' What are some precautions which everybody who desires to remain capable of learning should bear often in mind? In which if either of the two types of learning is the danger of stagnation the graver? Why?

SELECTED REFERENCES

1. Meumann, E. *The Psychology of Learning*. (Tr. by Baird.) (General Reference.)
2. Pyle, W. H. *The Psychology of Learning*, chapter 1.
3. Thorndike, E. L. *Educational Psychology*, vol. 2, *The Psychology of Learning*. (General Reference.)

[illegible]

LESSON 5

TWO GOALS IN LEARNING: HABIT AND KNOWLEDGE

Experiments:

3. *A free-association experiment.* The facts brought out in this chapter may be established experimentally in various ways. One valuable experiment will be to have *E* prepare a list of ten words that are rich in associative meaning and give them one by one to *S*, allowing him in each case sufficient time to write down the first word or words that come to his mind. Or, if there is not time during the laboratory period, the instructor may prepare a list of such words and give them slowly to the entire class, each student to note down the reaction word immediately. Words such as the following will serve to illustrate the principle, brought out in the lesson, that knowledge of a thing consists fundamentally of familiarity with its meaning or relationships: (1) psychology; (2) Tennyson; (3) gravitation; (4) laboratory; (5) Foch; (6) biplane; (7) photographer; (8) factory; (9) Victrola; (10) thrift. Each student should arrive at the conclusion that ideas are associated together in the mind as a result of one's own individual and personal experiences. By comparing notes the subjects will discover that other individuals, while their associates are similar in general, have had somewhat different experiences, hence their associations in specific cases are slightly different. All ideas are the memorial traces left from personal experiences.

4. *A free-association experiment.* A similar experiment in uncontrolled association may be tried, as follows. *E* instructs *S* to start in at once at the signal with some word, and to keep on saying words as rapidly as possible until one hundred have been given, when *E* will say "Stop!" *S* should understand that it is a matter of indifference what words she gives, as long as they are isolated words, not words in sentences. *E* should note down each word given by *S*, and keep a careful record of the time required to complete the list of one hundred. It will be found helpful if blank forms, containing spaces for one hundred words, have been prepared beforehand. Subsequent inspection of the list will reveal several distinct chains or series of associations which *S* has linked up. Comparisons of the lists made in the various laboratory

groups will reveal many other points of interest, such, for example, as alliterative associations, prevalence of nouns, words used in common, etc. If *E* notes down the number of seconds at the completion of each block of ten words, the increasing necessity of arousing more outlying terms will be brought out in the greater amount of time required in blocks subsequent to the first two or three. (Jastrow found in tests of college students an *average time* of 130 seconds for oral lists of one hundred words.)

Classification of the learning process. For purposes of clarity it will be well for us to classify the learning process according to the following four principles:

(1) According to the goal to be achieved by the learner:
  a. Skill.
  b. Knowledge.
(2) According to the rank of the learner:
  a. Animal learning.
  b. Human learning.
(3) According to the type of learning involved:
  a. Sensori-motor learning.
  b. Perceptual learning.
  c. Associative learning.
(4) According to the method employed by the learner:
  a. Trial and error.
  b. Imitation.
  c. Reflection.

In this lesson we shall be concerned with the first of these classifications only: the goal to be achieved by the learner. It should be stated at the outset that these four phases of learning will be found in many cases to overlap one another. Animal learning, for example, under (2), results in skill, under (1); involves sensori-motor learning, under (3); and is characterized by trial and error methods, under (4). We shall find the classification a convenient one, however, to bear in mind in our study of learning or acquisition in the coming lessons.

Two goals in learning: (1) habit. Let us start with an analysis of the learning process from the viewpoint of the goal to be achieved as the result of learning. In general we may say that the end of learning may be either one of two things: skill in performance, or the acquisition of knowledge. In the preceding lesson most of the illustrations of learning employed were examples of skill in *doing* something. This word doing expresses excellently the spirit of learning of the first sort, for in all learning in which skill is the goal the development of control over muscular movements is the end sought. This control may vary all the way from the nicely coördinated movements of the expert watch repairer or the expert needle worker, to those of the 'crack' batter or the 'ace' flyer. The same condition underlies all of these performances: muscles trained by practice to a high degree of skill.

Consciousness and attention, of course, play important rôles in the development of human skills, but only as necessary initial means to an end. The bicyclist, for example, must attend closely to his hands, his feet, and his entire body mass during early practice periods, else he will topple over in spite of himself — as he usually does more than once during the initial trials. He finds it necessary consciously to image beforehand the pressing upon this pedal and then upon that in order to propel the bicycle and to balance it, and he is conscious of the process of pressing while he is doing it. Subsequently the conscious and volitional aspects drop out as he becomes more and more proficient, until soon he develops a skill at pedaling, guiding, and balancing which is almost absolutely muscular in character. True, so intimately related were these triple skills, in their genesis, to consciousness, that it is a very easy matter for consciousness to reassert itself and assume a directing control over them at any time. In actual performance such control is superimposed but rarely, and when it is the wonted fineness of coördination is likely to be seriously interfered with. Thus, Swift found, in his ball-tossing experiments, that when he attended consciously to the movement of his hands, the balls which he was endeavoring to keep in the air passed rapidly beyond his control: it was necessary to attend to the *balls*, not to the muscles. So indeed with any other act of skill: attempts to superimpose cerebral direction upon lower-level responses are likely to prove uneconomical and even disastrous. Can you cite illustrations from your own observation or experience?

We are already familiar with the formula:

Situation ⟶ Bond ⟶ Response

In the case of habit (i.e., controlled motor coördinations) it is usually the case that a particular state of consciousness initiates a particular movement or series of movements. The state of consciousness comprises the perceptive aspect of the situation, the motor reaction resulting from it comprises the response, while the bond is of course the neural route connecting the former with the latter. Instead of perception being associated with another idea or series of ideas, as is true in the case of strictly mental states, the perception is discharged directly into the motor neurones on lower levels, and we have the phenomenon of habit. Habit is not then a non-cerebral response of a purely automatic nature, comparable with the heart-beat or the internal secretions of the organism; it is rather a conscious awareness of a definite situation, on the one hand, and the customary motor reaction to it, on the other. This awareness or comprehension of the situation is rarely raised little more than just appreciably above the threshold of consciousness, as in the case of the automobilist who sounds his horn as a matter of course at a cross street, or the writer who dips his pen in the ink-well upon becoming aware that his writing is growing faint. In occasional cases, however, the situation may be very strictly and attentively attended to, as in the case of the pianist who fingers the keys softly at *diminuendo*, or the typist who manipulates the machine with extreme care while inserting a letter that she has omitted in the preceding line.

We stated above that perception of a definite situation, to which we have previously reacted habitually in a definite way, causes discharge directly into the customary motor channels. It is also true that an idea, as well as a perception, may initiate habitual motor reaction. Thus, sight of the tooth-brush hanging over the washstand (perception) may impel me to brush my teeth; or again, the thought that it is my usual time for brushing them (idea) may equally impel me to do it. Where such motor response is initiated by an idea rather than by a perception, we ordinarily refer to the action as *ideo-motor action*.

Motor habits but chains of simple acquired reflexes. If now we attempt to analyze the motor responses to either a perception or an idea, we shall discover that they are less simple than at first appears. In writing the sentence upon the typewriter we conclude that the perception of the copy comprises the situation, and that the reproducing of it comprises the response; and we are right. But this seemingly simple motor response is really a complex chain of what we may call simple acquired reflexes.

To illustrate. Suppose the stenographic copy calls for the writing of the following sentence: "Business conditions in Russia are extremely uncertain." If we analyze the typist's consciousness during the process of reproducing the sentence we shall probably find some such sequence of events as this: "Wanted: *capital B*. Press down this shift key and strike *b there*. Now I am conscious through muscular sensation that *B* has been written. This is my 'cue' for striking *u here*. I am conscious through muscular sensation that I have written *u*. This sensory awareness is my 'cue' for the next letter, *s*, which I repeat in vocomotor image, and of whose position on the keyboard I have instantly a muscular image, which draws my finger to the appropriate key. Sensory consciousness of having written *s* becomes in turn my 'cue' for *i*, to the pressing of which the same images draw my finger. And so with each succeeding letter in transcribing the word "business."

When I am muscularly aware that I have struck the last *s* in business, images of the copy interpose and combine with this awareness to impel my finger to the spacer. Awareness of having spaced, plus the interposing of the copy image, combine in forming my next 'cue,' and I respond by striking the *c* in the next word."

What is taking place then throughout the entire process of typewriting is a series of definite and simple reflexes that the typist has acquired through practice. Viewed *as a total*, typewriting appears to be a highly complex skill — which indeed it is; but analyzed into its parts it is seen to be comprised of a long series of links which are identical in the manner of their forging in the neuro-muscular system. Obviously the efficient typist is not compelled to make use of any high degree of concentration in the linking up of the chain, for the responses to the images have become reflex through practice. Throughout the process, however, sense-perception must constantly obtrude to furnish the sensations of movement,[1] on the one hand, and the consciousness of the general scheme or plan to be executed, on the other.

A second goal, knowledge. As we have seen, one goal of learning is the development of motor control, which we call habit. The other goal, to which we now turn our attention, is the *acquisition of knowledge.* What then do we mean by knowledge, and how is it to be obtained? Socrates, in his philosophy of education, offered to the world four hundred years before Christ, ascribed virtue to knowledge, arguing that by developing in himself the power of straightforward thinking the individual would be enabled ultimately to possess complete knowledge, and hence could not be rationally guilty of wrong conduct. Theoretically, Socrates' doctrine was sound, although in practice it does not always follow that knowledge makes for virtuous conduct. We are of course not interested here in philosophical speculation concerning knowledge, although we may well pause with Socrates to reflect upon the true dignity and worth of knowledge as a factor in the control of conduct. What we are especially concerned with are the psychological principles lying back of the gathering of knowledge as one of the dual processes of the educative process.

---

[1] In pathological cases, such as locomotor ataxia, in which sensations of movements of the limbs are no longer receivable, the patient often becomes totally unable to walk, although there is no impairment of muscles or of motor neurones. This indicates the tremendous importance of normal sensations in supplying images of movements, even though those same movements have been reduced to the levels of automatic behavior.

In the genesis and development of habit we found that motor coördinations played the major rôle, and that sensations and images, while indispensable both to the process of habit formation and to the repetition of an act after it has become habitual, were secondary factors. In knowledge acquiring, however, this is by no means the case. The goal of knowledge is not essentially muscular movement, but rather ideas. The performance of a motor series is dependent upon a lowered neural resistance to the discharge of perception directly into related motor channels; the functioning of knowledge, on the other hand, is dependent upon a lowered neural resistance to the discharge of perception (or idea) into related ideational channels. Movement, while it may and often does occur as a result of the latter type of discharge, is not an essential accompaniment of it, as it inevitably is in the case of habit.

Knowledge results from the building up of associations.
To illustrate the building up of knowledge. Suppose a primary teacher is striving to teach her children to know, at sight, certain of the simpler sums. At the outset, on the assumption that none of the children has had any previous experience with these combinations, such visual or auditory stimuli as:

$$\begin{array}{ccccc} 2 & 4 & 2 & 6 & 4 \\ \underline{2} & \underline{3} & \underline{5} & \underline{2} & \underline{4} \end{array}$$

elicit no intelligent responses. They have as yet no conception of the meaning of numbers in the abstract. By virtue of careful drilling in the concrete, extended over many days and varied as ingeniously and motivated as cleverly as her art can make possible, the teacher must slowly build up in the minds of the pupils certain readinesses to appropriate response to each combination in whatever situation or surroundings it chances to be met. 2 + 2 must always suggest to the child who confronts it 4; 4 + 3, 7; and so on with all possible combinations. In later grades these same pupils should react as instantaneously and with as little conscious exertion or even reflection to 9 + 9 = ? or 8 + 7 = ? as they do to any situation which impels to strictly motor habit response. And yet in these number responses there is not necessarily any observable muscular movement. A child may *think* 9 + 9 = 18 without the observer knowing at all what he is thinking, the reason being that he is responding to the perception 9 + 9, or to the idea 9 + 9, with the *idea* 18.

What, then, is the difference between a motor response (habit) which follows a perception or an idea, and a mental response which follows similarly a perception or an idea? Is not the latter just as much a *habit* as the former? In the broad sense, yes. In the strict psychological sense, however, we cannot properly designate the latter series of connections as habit, since the end is not muscular coördination, but rather mental coördination. And herein lies the cardinal distinction between a habit and knowledge: the former is the outcome of repeated motor connections, the latter of repeated mental connections, or *associations*.

From this point of view, the second goal of the learning process (knowledge) becomes merely a matter of building up in the learner mental connections or associations between one idea (or perception) and another idea. Isolated ideas possess no meaning until they are brought into relationship with other relevant ideas. In the case of the learner of number combinations, the important thing is that he come through practice and drill to associate 18 with 9 + 9; 56 with 8 × 7; 8 with $\sqrt{64}$, etc., etc., through the whole of the fundamental processes of arithmetic.

So also with the acquisition of historical or geographical knowledge. Paul Revere and Samuel Adams and George III, and the period 1775–1787, and the Boston Tea Party, and a host of other items *belong together*, and it is the aim of the teacher so to manage the study of history that such related facts shall be brought together in the mental experience of the class, in the expectation that whenever any one of them recurs to consciousness subsequently the others will tend to be drawn in. The Revolutionary period *means* these things.

Similarly in working out the climatic conditions of a region. Thus, in the case of the climate of California, the mountain barrier on the east, the prevailing western winds from the great Pacific, and the amount of moisture present in consequence, represent a series of related facts which justify the conclusion that California has a high temperature in winter and a pleasant climate in summer. These are all items to be brought together in the mind of the pupil. It therefore becomes a prime aim of the geography teacher so to manage the study of the subject that they shall be brought thus together in the minds of the learners, to the end that in the subsequent use of their knowledge they may be able to reëstablish at will the causal series of climatic conditions in this or any other region.

The Law of Dynamo-Genesis. In all this process of knowledge building, as we have pointed out, there is not necessarily any apparent muscular involvement: the goal to be striven after is the association of ideas or perceptions with other and still other ideas until the chain of relationships is tolerably complete. This does not preclude the possibility of motor accompaniments and motor consequences. Professor James contended that "all consciousness is motor," by which he meant that every conscious state results normally in some sort of motor response or tendency to response. This principle has been called the *Law of Dynamo-Genesis.*

Some simple illustrations of this law are seen in such responses as stooping to pick up a pencil which one has dropped; turning the head to glance at the clock, or removing the watch from one's pocket in consequence of wondering what time it is; opening the window when one becomes conscious that the room is becoming too warm; etc. Such responses are simple and immediate reactions to simple conscious states, the vivid images of movements discharging into the impulse to perform them. This simplicity and immediacy of physical response upon conscious states is characteristic of the animal especially. In man, however, with his measure of control over impulses, his vivid representation of past experience, the greater complexity of his nervous organization, with the possibility of discharge of ideas into other ideational pathways rather than into direct motor neurones, and his supreme ability to weigh, judge, and reason, the principle of dynamo-genesis [1] does not always operate immediately and tangibly.

---

[1] Recent developments in experimental physiology support this principle of dynamo-genesis, and suggest the extreme probability that every well-defined conscious state in which there is any trace of emotion attached is reflected in the internal workings of the organism, even though it may not lead to appreciable external motor reaction. From everyday experience we are familiar with the 'heart-in-the-mouth' sensation which is often present in conscious states of fear or anxiety; the changes in the circulatory system in states of suspense or elation; the mouth-watering phenomenon attendant upon the thought or the perception of a much-liked dish; the visceral depression in states of repugnance and *ennui*. Such organic changes as these represent nothing else but modifications of the tensity or relaxation of the muscles in the walls of the blood vessels and glands. Now when these well-known phenomena are brought under experimental analysis in the laboratory, not only are they confirmed, but far more intricate organic accompaniments of or reactions to conscious states are come upon. It is found, for example, that the flow of saliva, gastric juice, and other digestive juices is radically checked during states of uneasiness or fear; and that stress of emotion stimulates the activity of the adrenal glands which secrete, under such conditions of excitement, large quantities of adrenin into the blood. Even the ancients of India realized the invariable influence exerted by fear upon the flow of saliva, as shown by their 'ordeal of rice.' Lea tells us in his book, *Superstition and Force*, that whenever a crime had been committed and it was desired to establish the guilt of the perpetrator, all the suspected culprits were given a mouthful of the consecrated rice to chew. After a moment it was spit out on to a

But even though the two goals of the learning process (habit and knowledge) differ from one another in the matter of motor accompaniments, they are very similar indeed in another respect: both are achieved through the experience of the individual, and in consequence we may say with perfect truth that the physiological basis of the one is identical with that of the other. Nerve routes have been connected up by experience or practice, and once they have been thus connected tend thereafter when aroused to re-establish the same connections as originally made. Situation is bonded to response in the one case no more truly than in the other. To react to the situation: 'strike key *s* on the typewriter' is, physiologically speaking, no different from reacting to the situation: '8 × 7'; there is an externally or an internally aroused situation; there is a preferential nerve route of low resistance; there is a motor or an associative response whose appearance is immediate and whose accuracy is tolerably invariable.

What is the function of knowledge? If one were to place a telephone instrument before a savage, he would not be surprised to find the savage staring at it uncomprehendingly. So a child gazes in bewilderment at the reflection of its face in the mirror, or at the slow-swinging pendulum of the hall clock. A visitor at the electrical plant encounters scores of devices whose significance is lost upon him. A novice in the chemical laboratory sees paraphernalia and processes which he cannot fathom or comprehend. A page of Greek to the man who knows no Greek is totally incomprehensible. In all of these instances the persons concerned may be said to be ignorant, i.e., *to lack knowledge*, of the objects before them. In a similar way and for a similar reason every person lacks knowledge of every object and every process *previous to experience* with it.

What then is the function of knowledge? The question

leaf of the sacred fig tree. He who ejected it dry was clearly guilty, since fear of discovery had checked the salivary flow and condemned him *prima facie*. No circumstantial evidence could be stronger.

is easily answered. The function of knowledge is *to give meaning to those things in the world with which we are in any way concerned.* Hence it is that those things in our experience that we know best are those things that have for us the most meaning. Whatever things lie outside of and beyond our experience have for us no meaning. Similarly with those things of which we have partial knowledge: they possess partial meaning for us.

Knowledge is then, after all, but a relative term. Were absolute knowledge attainable in anything, it follows that those who were possessed of it would know the full and final meaning and relationships of that particular thing, and perhaps also of everything else. But absolute knowledge appears to be unattainable. We have knowledge of electricity, but nobody really knows what electricity is absolutely. We have knowledge of a blade of grass, or a whirling planet, but our knowledge is far from absolute. As the poet expresses it:

"Flower in the crannied wall,
I pluck you out of the crannies,
I hold you here, root and all, in my hand,
Little flower — but *if* I could understand
What you are, root and all, and all in all,
I should know what God and man is."

Progressive knowledge. Within the limits set by the nature and relativity of knowledge, the learner of anything is then faced with getting as much of the meaning of that thing as possible. He must know it in its relationships. From the earliest days of his conscious life the child is at work upon this problem of extracting meaning from objects. At first he limits his analytical efforts to concrete and material objects; later, however, he seeks meanings and relationships from abstract and immaterial data. For him individually nothing exists until he has assigned to it some definite place in his system of organized meanings. When he can name a thing definitely, or can recognize it from hearing it named, he has at least the nucleus of knowledge about that particular thing. At first his knowledge of the meaning of an object is restricted largely to the simple uses to which that object can be put. Never mind. That is just as certainly knowledge as it would be if it were a comprehension of relationships and categories other than use. This latter phase of knowledge-getting — namely, the placing of objects and principles in the perspective of their relationships — but waits on the accumulating experience and developing maturity of the learner.

Let a picture-book be placed for the first time in the hands of an infant. 'Pretty picture-book!' explains the mother, as she encourages the child to open it. After some moments of fumbling at it, with or without the mother's assistance, the child eventually succeeds in turning over some of the pages. Once or twice, it may be, its attention is caught for a fleeting time by a prominent picture. Shortly afterward it throws the book from it and seeks other means of entertainment. What traces of this experience remain in the infant's mind when, some hours later, the picture-book is again placed before it? Obviously now the object possesses some nucleus of meaning. It contains certain things which give satisfaction to look at; it is something to be manipulated and which, when manipulated in a certain way, rewards by giving more satisfaction. After a few more days of entertainment the infant comes to have the idea picture-book definitely in its mind whenever it thinks of it; and to be able to recognize the object at sight as 'picture-book.'

What it has done really has been to form certain constant associations or meanings. There is an association between the perception of the book upon the floor and the name 'picture-book' which the mother has so often pronounced as she passed it to him; there is an association between the idea 'picture-book' and the idea 'something satisfying to look at'; there is an association between the idea 'picture-book' and the name 'picture-book.' In subsequent experience with it additional associations will be built up, as for example between a certain definite picture of a dog and a page near the middle of the book; or of a teddy-bear and the back cover; or of a pretty baby and a page near the front of the book; etc., etc. So also there may come to be built up in the infant's mind an association between the idea 'picture-book' and the shelf where it is kept, or between sight of Uncle John and story-of-the teddy-bear in the picture-book, which Uncle John always reads to baby. And so on, until the infant has attained a complete knowledge of that particular picture-book; i.e., until all its possible meanings and relationships have been assigned.

How does the school function in the building up of knowledge? Let us consider an illustration of the way in which the school child comes to know an object through an investigation of its uses. Suppose the lesson is on the very important subject of leather. The combined experience of the class through previous contacts will furnish the information that leather is used in the manufacture of a great number of articles which make for the comfort and enjoyment of man — gloves, shoes, book-bindings, skate-straps, belts, purses, furniture upholstery, bags, harness, coach and automobile cushions, etc., etc. The aim of the lesson will be to discover the sources of leather, the methods of preparing it from the raw material, and its importance as a commercial product. This will involve a study of the various hides of animals — cattle, sheep, goats, mules, etc. — with a classification of animal leathers into calfskin, sheepskin, kid, muleskin, etc., and the common uses to which they are put in the manufacture of various leather products. It will involve a study of production areas for all kinds of raw leather. It will involve a study of tanneries and the processes of manufacture of the completed product. After a lesson or a series of lessons of this sort, the knowledge of leather which the class will have will be tolerably complete, so far at least as the aims and purposes of the school instruction are concerned. Leather as a concept will be comprised of a great number of associated meanings in the minds of the pupils. They will know leather in its fundamental relationships: its sources; its uses; the processes of its manufacture; its importance in industry and commerce.

In so far as it is a function of the school to foster the building up of ordered knowledge in its pupils, it proceeds in all other things exactly as it does in the case of leather. It seeks to interpret the chief objects, personalities, events, and principles of experience in terms of their human relationships. The goal is ever to increase the capacity of the pupil to control these objects, personalities, events and principles, and so make them of service to himself either materially or spiritually.

To illustrate: Is it the product, iron? the learner is concerned with the discovering of its chief human relationships in order better to comprehend its uses and its indispensability. Is it the industry, lumbering? the learner is concerned with finding out the story of lumber in order that he may know the rôle played by lumber in the affairs of men. Is it the event, the surrender of Lee? the learner is concerned with weaving over again the whole fabric of the Civil War, with the goal of discovering why the defeat of the Confedcracy was inevitable, why the ideals of the North triumphed, and what the great lessons for democracy were in the conflict. Is it the principle, healthy teeth are clean teeth? the learner is concerned with finding out something of the anatomy of teeth, how decay starts, how they may be kept from decay, etc., all to the end that he may personally be fit for life's race, so far at least as good teeth are an essential to the running.

Learning of relationships. Looked at from this point of view, knowledge-getting is seen to be merely the learning of relationships, and such indeed is what knowledge essentially is. True, the philosopher goes somewhat further. He presses his inquiry into the nature of knowledge itself, and its relationship to the infinite. But even his goal is no different from that of the youthful learner. He strives by virtue of his deeper insight to define human relationships more closely and intimately by inquiring more profoundly into the universality of knowledge. Thus, the knowledge after which the metaphysicist and the teleologist seek and the knowledge which the school seeks to make accessible to its pupils is after all but a comprehension of meanings and relationships, in the expectation and hope that the learner who has appropriated these meanings may the more intelligently and happily bend to his own uses the forces concerned.

Take the knowledge involved, for example, in the navigation of the air. In the two last decades tremendous advances have been made in this fascinating project. To sail in the sky in a heavier-than-air ship seemed all but unthinkable yesterday. Yet what has happened? A few clever scientists, first getting the vision and having the courage of their convictions, set about studying atmospheric conditions and laws in the belief that they could in a measure at least conquer the air and so open it up to human relationships. Through indefatigable experimenting they were eventually able to fly in heavier-than-air planes. Thus has knowledge about atmospheric conditions and the principles of aeronautics led to control of the air, just as knowledge of electricity and of other gigantic forces has led to practical control over them. Experiments in wireless telegraphy and wireless telephony are establishing still other relationships with the air. This establishing of relationships is the goal, as we have said, of all knowledge, whether it be done in the schoolroom or in the laboratory. The former of these — the schoolroom — is society's scheme of aiding the generations, age by age, to establish the most fundamental of these human relationships in the consciousnesses of the children as economically and efficiently as possible.

The child should be constantly searching after these meanings. If such is the nature of knowledge, it follows that the child should continually be found in quest of meanings of objects, personalities, events, and principles, and that the school should primarily be a fosterer of such a quest. In his pre-school years, the child is normally and persistently such a seeker after meanings, as witnessed in his incessant questionings and experimentings. But when the school years come, we are too apt to lock him away with books until his spirit of quest becomes laden with the weight of our teaching methods, and he loses his vibrant, buoyant interest in meanings and relationships of human significance. Through faulty motivation we upset his scale of values, and through wrong emphases we obscure his goal. What wonder that he languishes often, and occasionally gives up in despair! Let the school beware lest in its organized and methodized and curricularized zeal to lead its children by leaps and bounds, it take away from them the initiative and driving force which are indispensable in the quest after knowledge.

The attitude of the learner should be always the attitude of the inquirer, the searcher, the investigator, the experimenter. Why do I perform this process? Why does this always lead to that? Why is this important? What is the "spirit of '76"? Why the "Boston Tea Party"? Why the War of 1812? What the influence of *Uncle Tom's Cabin*? Why is the John Brown incident important? Why the Emancipation Proclamation? What was the real issue behind the Civil War? Why was the cotton-gin so important? Why is Palm Beach a favorite winter resort? Why is Bar Harbor a favorite summer resort? Why did New York develop so rapidly? Why Chicago? Why is the Panama Canal important? Why is New England a manufacturing region? Why are cotton mills springing up in the South? Why does the United States export tobacco? Why import sugar? Why is Chicago the center of the great meat-packing industry?

The school which makes it possible for boys and girls to engage in the solution of problems such as these in history and geography, and similar ones in general science, civics, literature, hygiene, etc., will be phenomenally successful in stimulating its pupils to search after meanings and establish relationships between facts, thus building up knowledge in the truest sense. The danger is of course that the school, instead of providing an attractive *milieu* and the necessary equipment wherein and wherewith the learners may investigate meanings and relationships, will provide but second-hand contacts through the printed page and the spoken word. The important thing about the acquisition of knowledge is that it *be sought after actively, not passively imbibed.* To make this possible requires a high degree of cleverness and foresight on the part of the teacher. The easiest way, the way of least resistance — for example, in learning why New England is a great manufacturing region — is for the teacher to provide the book or books and indicate the pages in which the fact with the appended reasons is stated. The harder way, the way that requires the spirit of quest, is for the pupils by the use of geographical maps and railroad maps and the constant exercise of gray matter to arrive at the conclusion through their own efforts. This is real teaching and real learning, as opposed to the 'pouring-in' process, still so prevalent in much of the teaching of youth.

Working out fundamental relationships. It is to sound forth this gospel of active quest in the building up of knowledge on the part of boys and girls that Dewey takes pains to describe somewhat in detail how the children in the University Elementary School are encouraged to work out fundamental relationships for themselves in the building up of their knowledge. I can think of no better illustration of this active quest after knowledge than that of the way in which these same children of the University Elementary School learned about cloth. To quote from Dr. Dewey:[1]

> . . . In connection with these occupations, the historic development of man is recapitulated. For example, the children are first given the raw material — the flax, the cotton plant, the wool as it

---

[1] Dewey, John. *The School and Society*, pp. 34 ff.

comes from the back of the sheep (if we could take them to the place where the sheep are sheared, so much the better). Then a study is made of these materials from the standpoint of their adaptation to the uses to which they may be put. For instance, a comparison of the cotton fiber with wool fiber is made. I did not know until the children told me that the reason for the late development of the cotton industry as compared with the woolen is, that the cotton fiber is so very difficult to free by hand from the seeds. The children in one group worked thirty minutes freeing cotton fibers from the boll and seeds, and succeeded in getting out less than an ounce. They could easily believe that one person could only gin one pound a day by hand, and could understand why their ancestors wore woolen instead of cotton clothing. Among other things discovered as affecting their relative utilities, was the shortness of the cotton fiber as compared with that of wool, the former being one-tenth of an inch in length, while that of the latter is an inch in length; also that the fibers of cotton are smooth and do not cling together, while the wool has a certain roughness which makes the fibers stick, thus assisting the spinning. The children worked this out for themselves with the actual material, aided by questions and suggestions from the teacher.

They then followed the processes necessary for working the fibers up into cloth. They reinvented the first frame for carding the wool — a couple of boards with sharp pins in them for scratching it out. They redevised the simplest process for spinning the wool — a pierced stone or some other weight through which the wool is passed, and which as it is twirled draws out the fiber; next the top, which was spun on the floor, while the children kept the wool in their hand until it was gradually drawn out and wound upon it. Then the children are introduced to the invention next in historic order, working it out experimentally, thus seeing its necessity, and tracing its effects, not only upon that particular industry, but upon modes of social life — in this way passing in review the entire process up to the present complete loom, and all that goes with the application of science in the use of our present available powers. I need not speak of the science involved in this — the study of the fibers, of geographical features, the conditions under which raw materials are grown, the great centers of manufacture and distribution, the physics involved in the machinery of production; nor, again, of the historical side — the influence which these inventions have had upon humanity. You can concentrate the history of all mankind into the evolution of the flax, cotton and wool fibers into clothing. I do not mean that this is the only, or the best, center. But it is true that certain very real and important avenues to the consideration of the history of the race are thus opened — that the mind is introduced to much more fundamental and controlling influences than usually appear in the political and chronological records that pass for history.

QUESTIONS AND PROBLEMS

1. What is meant by 'reaction time,' and what relationship does it bear to the subject-matter of this lesson?
2. The statement is made in the text that simple motor responses are, when analyzed out, a series or chain of simple reflexes that have been acquired through practice. In the light of this explanation, write out an analytic description of the motor responses which a pupil makes in writing a sentence in his notebook.
3. Make a list of ten illustrations of ideo-motor action.
4. Trace the process by which the child arrives at the point where he reacts instantaneously and reflexly to the situation: 9 × 7 = ? with '63.'
5. Illustrate as concretely and vividly as possible the truth of the statement: isolated ideas possess no meaning until they are brought into relationship with other relevant ideas.
6. What establishing of relationships on the part of the learners is involved in the building up of knowledge about coal? Benjamin Franklin? The Lewis and Clark Expedition? Atmospheric pressure and the weather?
7. Why is 'self-activity' coming more and more to be a keynote in modern educational method?
8. Read and report upon some recent article in the literature bearing upon teaching methods such as are advocated in the lesson.

SELECTED REFERENCES

1. Breese, B. B. *Psychology*, chapter 18.
2. Colvin, S. S. *The Learning Process*, chapter 13.
3. Pyle, W. H. *The Psychology of Learning*, chapter 6.
4. Strayer, G., and Norsworthy, N. *How to Teach*, chapter 5.

LESSON 6

HUMAN AND ANIMAL LEARNING

Experiments:

5. *Mirror-drawing experiment.* The experiments suggested here are arranged to demonstrate the 'trial and error' method of motor learning. The first is the so-called 'mirror-drawing experiment,' which demonstrates excellently the process of learning a new and undeveloped act. Draw on a piece of pasteboard a six-pointed star by pricking through the apices of Fig. 4, and connecting with pencil the twelve points thus fixed. Trim the card, and using the star as a pattern trace on several sheets of paper an outline similar to Fig. 4. Draw a line at *a* to indicate the starting point and an arrow (*b*) to indicate the direction to be followed. Next place a mirror at right angles before *S* on the table in such a way that he can plainly see the star outline in it. Clamp a cardboard to a tripod, so that *S* cannot see the outline directly but only indirectly in the mirror. *S* is instructed to place his pencil at *a* and, upon signal from *E*, to trace along the outline of the star in the direction indicated by (*b*), looking always in the mirror rather than at his hand directly. *S* should not remove his pencil from the paper; if he finds that he is diverging from the line he is to try to get back to it. *E* should keep a careful record of the time required by *S* to trace a complete circuit of the figure; also of the number of errors; i.e., correcting movements, made. Each attempt to return to the line, whether successful or not, is to be reckoned as an error. Repeat nine times. After the completion of the ten trials, *S* should write out his introspection, bearing in mind especially the part played by thought and reasoning, random movements, affective attitudes, etc. The results should be preserved carefully for subsequent tabulation and portrayal graphically.

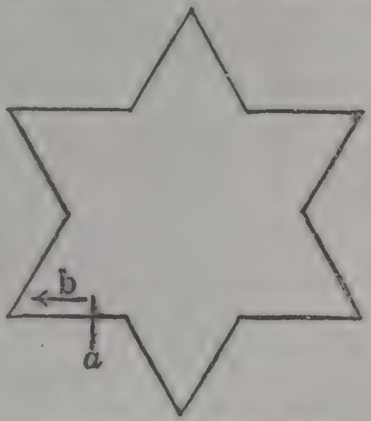


Figure 4. Mirror-Drawing

6. *Puzzle-box experiment.* For this experiment, either Healy's Puzzle Box or Freeman's Puzzle Box may be used. Fig. 5 represents Dr. Healy's (procurable from C. H. Stoelting Co., Chicago).

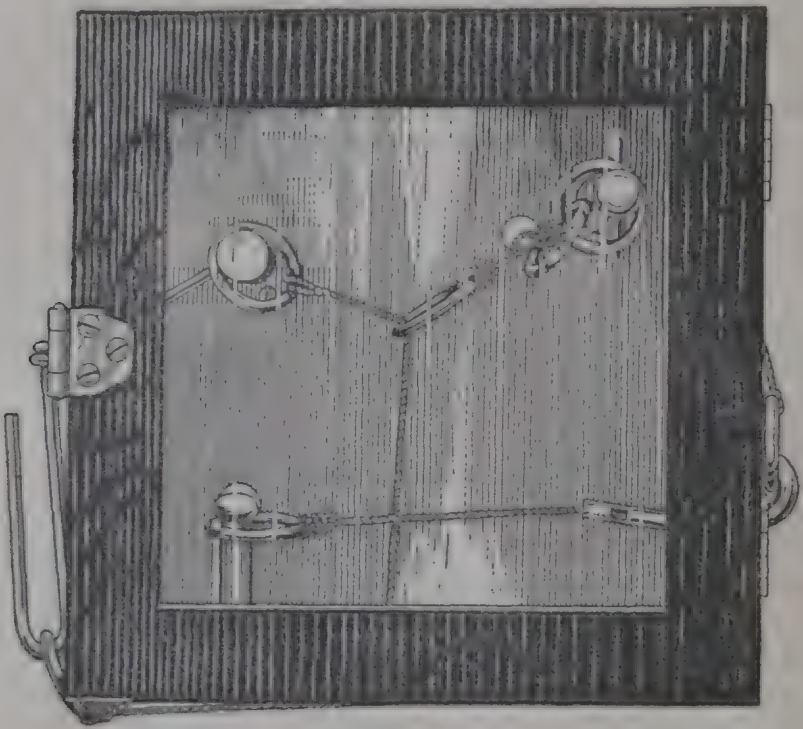


FIGURE 5. HEALY'S PUZZLE BOX

The door of the box can be opened only after a series of fastenings has been manipulated. Without any previous opportunity to study the box, *S* should be given the instructions to open it as quickly as possible without straining the fastenings. *E* should keep a record of the time from the instant when *S* attacks the problem until the door is finally opened. He should also note down all evidences of trial and error manifested in *S's* performance. Immediately after the door has been opened, *S* should write out his introspection, bringing out especially the respective parts played by random movements and by reflection.

[If neither Dr. Healy's nor Dr. Freeman's box is available, the instructor may, with a little ingenuity, construct one which for the purposes of the experiment will be quite as satisfactory.]

7. *Tait's labyrinth puzzle.* *E* should draw beforehand several diagrams like Fig. 6. At the signal *S* is to trace the outline uni-

cursally as rapidly as possible, without removing his pencil from the paper until either he has 'penned' himself, or has come back to the starting-point by a single tracing. If the first attempt is unsuccessful, *S* should repeat the trials until a successful outcome is had. The time should represent the duration of the trials; i.e., if the third trial is the successful one, the time consumed in attempts 1 and 2 should be included. *S* should forthwith write out a description of the methods by which the problem was solved, paying special attention to conscious planning and random movements.

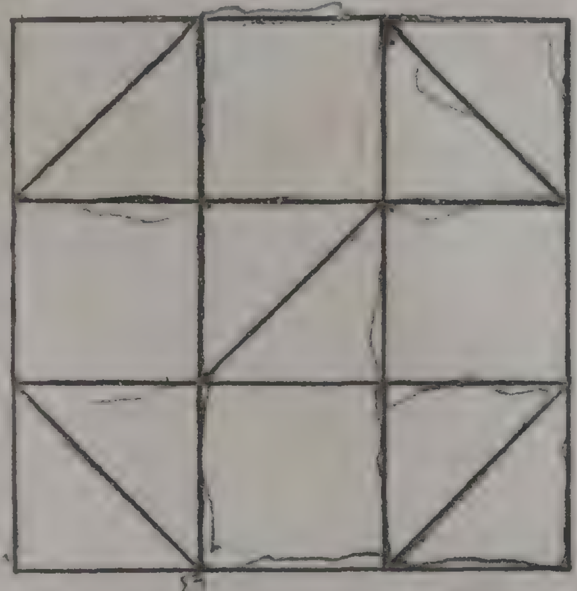


FIGURE 6. TAIT'S LABYRINTH PUZZLE

Problems of Comparative Psychology. Having classified the learning process according to the goal to be achieved by the learner (skill or knowledge), we turn next to a discussion of the learning process as classified according to the rank of the learner (human learner or animal learner). Human beings and animals have very many characteristics in common, and at the same time possess some fundamental characteristics that are totally different each from the other. In this lesson we are to be concerned (1) with a study of the methods employed by animals in learning new responses, and (2) with the points of similarity and disparity between such learning and that of human beings in similar situations.

Within the past quarter of a century a considerable number of investigators have been engaged in the very fascinating project of animal experimentation, with the end in view of analyzing the processes whereby animals learn. As a result of their inquiry into the nature of non-human learning we are now in a position to draw certain conclusions from animal psychology, with a fair assurance of accuracy. Obviously comparison and contrasting of human psychology with animal psychology bring out certain common elements peculiar to the learning process of both types, and at the same time certain elements which typify only the one or the other. Various animals have been used in the laboratory as 'learners'; notably, guinea pigs, rodents, chicks, raccoons, kittens, dogs, turtles, birds, and monkeys. Elaborate devices have been worked out by which to induce responses in these and other animals, and to study the steps through which responses become automatized.

That branch of psychology which is concerned with the general study of the behavior of animals has come to be known as *Comparative Psychology*,[1] inasmuch as its prime purpose is to compare the mental life demonstrable in various types and levels of animals. Among the problems of the comparative psychologist are: To what extent do animals possess consciousness? Is the nervous system of animals capable of retaining images of past experience? Are the responses of animals in any measure governed by ideas? What part does imitation play in animal learning? What are the laws underlying the learning of animals? What methods do animals employ in adapting themselves to novel situations? What are the probable limits of animal learning?

We shall not attempt in this lesson to answer all of these and other questions arising out of the observational study of animal behavior, but shall limit ourselves to a description of the technique of animal experimentation, a review of some typical investigations, a summary of such of the conclusions of the comparative psychologists as bear upon the process, and a discussion of the points of similarity and difference between animal learning in general and human learning in general.

---

[1] Other psychologists give to the term *Comparative Psychology* a much wider significance, including within its meaning a comparison of the normal adult human consciousness with the consciousness of abnormal types, the child, the group, and the animals.

The technique of animal experimentation in the learning process. While the types of experiment that have been devised in different psychological laboratories in this and other countries have tested several other functions, notably sensory and instinctive characteristics, by far the most significant results for educational psychology have been achieved in experimentation upon the learning process in animals. Watson, one of the most indefatigable of animal psychologists, concludes that there appears to be almost no limit either to the number or the complexity of habits which the higher vertebrates are able to form.

The problems of technique in inducing animals to form habits are as challenging as they are numerous. In general, just as in the excitation of human response, some stimulus must be provided. This must be accomplished artificially by the experimenter, but in such a way that the receptors of the animal will be impressed sufficiently to give rise to some sort of movement on the animal's part. The stimulus most commonly used for the purpose of initiating action is food, the animal being maintained in a condition of readiness for food sufficient to guarantee efforts to secure it under controlled conditions. Other stimuli employed successfully include the proximity of animals of the same species but of the opposite sex, and the administering of punishment for failure, usually in the form of an electric current strong enough to disturb and annoy the animal. Under such urges as these, carefully controlled and conditioned, animals are constrained to react by making certain movements calculated to secure the reward or avoid the punishment, or both.

The puzzle box. Two devices are in common use in the laboratory study of animal learning: the 'problem box' or 'puzzle box,' and the 'maze.' The first of these devices, the problem box, was finally perfected by Thorndike, twenty-five years ago, and has since come to be widely used in the study of animal learning. It is unfortunate that, inasmuch as each investigator works independently, there are no standardized types of problem boxes, and hence no exact uniformity of results and no certainty of experiments made by one observer being duplicated and checked up by another. Notwithstanding these present limitations, however, some striking conclusions have been reached.

Fig. 7 represents a puzzle box, which may be taken as typical of them all. The stimulus — ordinarily food, as we have seen — is placed inside the box, where it is plainly visible or smellable to the hungry animal outside. In order to secure the food the animal must discover for itself the means of opening the door into the box. If more than one trial is to be given in a single day the animal, after succeeding in gaining admission to the box, is permitted to eat only a small portion of the food, being then removed by the experimenter and compelled to rediscover the means of access to it. After the successful completion of the last daily trial, it is permitted to eat its full ration of food in the box.

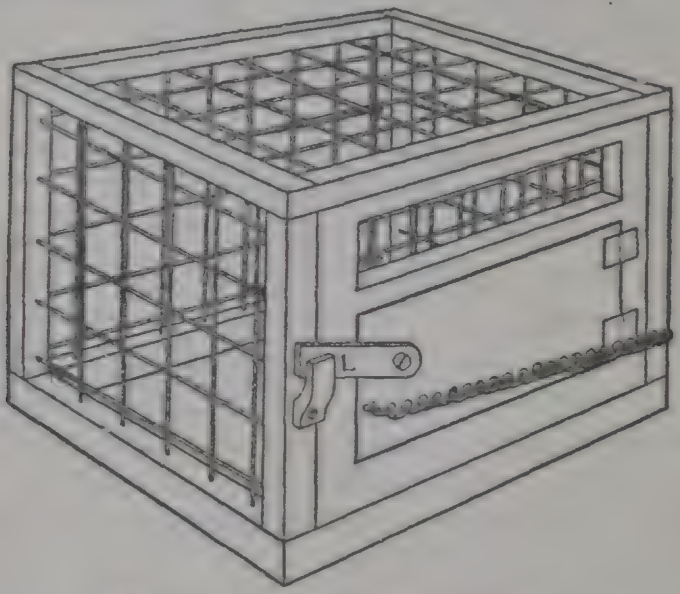


FIGURE 7. A TYPICAL PUZZLE BOX
(Reproduced, together with Figure 8, from Watson's *Behavior, An Introduction to Comparative Psychology* (1914), by courtesy of Messrs. Henry Holt and Company)

Fig. 7 represents one of the simpler types of door fastenings. Fig. 8 illustrates a box with more complicated fastenings. The actual fastening of this box is the hook at (5); but the hook cannot be moved until the button (at 4) is pushed to the left and out of the way; the button cannot be pushed back until the bolt (at 3) is slid; the bolt cannot be slid until the plug (at 2) is removed; in order to remove (2), however, the plug on the opposite side of the box (at 1) must first be pulled out. The necessary order of manipulation must therefore be 1, 2, 3, 4, 5. As compared with the complexity of responses necessitated in the unfastening of this door the opening of the door of the box shown in Fig. 7 is a relatively simple matter, requiring ultimately but a single movement in pushing up the latch (at L). The simpler device has been used by Watson largely with rodents and dogs.

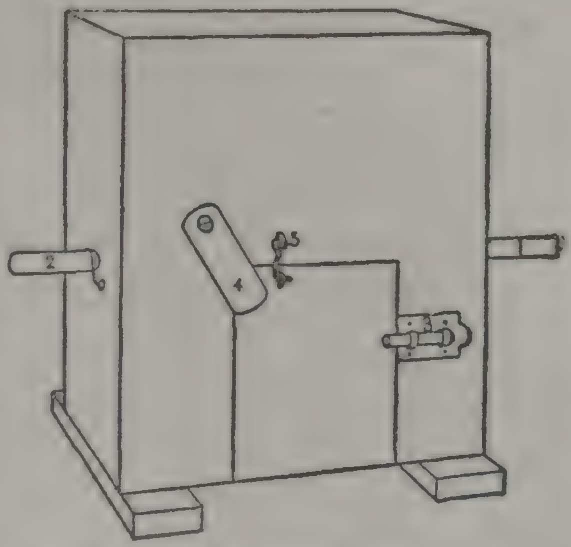


FIGURE 8. A MORE COMPLICATED PUZZLE BOX

The maze. The other device in common use in laboratory experimentation on the learning process in animals is the maze. The problem here is not to find a means of entrance into a box in order to secure food, but to discover among all the intersecting labyrinths within a box the sole alley which leads by a circuitous route ultimately into the food chamber.

Fig. 9 represents the so-called Hampton Court Maze, which has been used extensively in experimenting with rats, birds, squirrels, monkeys, and even man. It will be seen that *A* and *B* are but confusing '*culs de sac*,' blind alleys, which will bring the animal up against a blank wall whenever it attempts to traverse any one of them. The procedure in maze experimentation is as follows. The animal, in a state of readiness for food, is placed at *X*, while its ration of food is placed at *Y*. A careful record of the time and moves is kept by the experimenter. The animal wanders about in the maze for a considerable time, passing into now this blind alley, now that, and now this again. Sooner or later, however, it will chance to enter the food chamber at *Y*, where it receives its compensation in food. On succeeding days, or at other definite intervals, the animal is introduced a second and third time at *X*, in a similar state of readiness for food as before. What the experimenter is interested in particularly is the gradual elimination on the animal's part of all random moves, and its ultimate attainment of a familiarity with the maze that will enable it to run at once by the most direct route into the

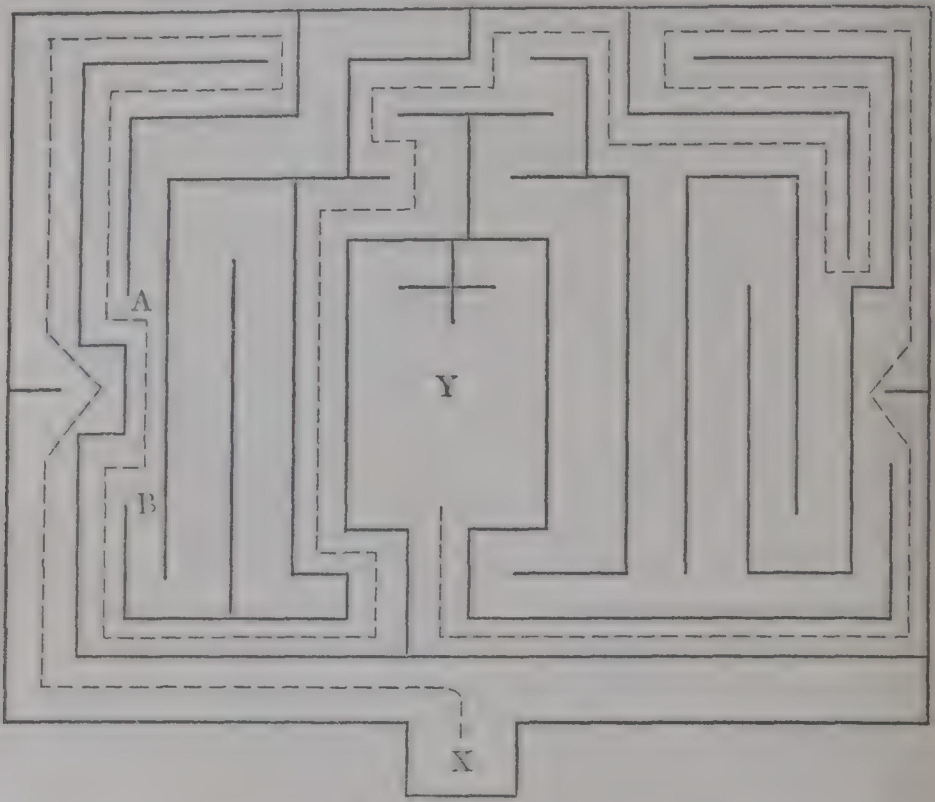


FIGURE 9. THE HAMPTON COURT MAZE

food chamber. These factors, carefully recorded, enable the experimenter to work out the laws of motor learning that are operative in the case of the particular animal being studied, and for the particular series of motor coördinations which the nature of the specific problem demands.

The method of trial and error. To this characteristic method of animal learning, which is dependent upon the elimination of random movements and the chance hitting upon the right movements, psychologists have given the name: *the method of trial and error*. Watson has described[1] the processes by which the white rat succeeds in securing food from a puzzle box which has been banked with sawdust, and entry to which is to be had only by burrowing into the sawdust and reaching the hole in the floor of the cage. His description of the behavior of the animal is a good illustration of the part played by the trial and error method in motor learning of animals.

> Running rapidly and walking slowly from place to place; sniffing, sneezing, washing the face or body; touching constantly the sides of the restraining cage and the box with vibrissæ or the bare snout, feet, etc.; clinging to all of the objects, sometimes with head up and sometimes with head down; crawling on the ceiling of the restraining cage; butting the nose into the crevices of the wire; gnawing at the wire and at all the wooden parts; pushing with great force against the box; stopping every few minutes to clean the paws of bits of sawdust; sitting up on haunches and chewing these bits; scratching at the sawdust with a group of characteristic movements which not only produce a hole but throw out the sawdust as well (this of course when the animal has had no experience with the sawdust); squeezing through holes so made; moving vibrissæ and nose across the bottom of the cage; mounting up through the hole; seizing the food; dragging it out to the nest, in case the latter is allowed, etc. This list is not by any means complete. These movements are repeated over and over again with ever varying order. Finally, however, the order is such that the food is obtained. The animal walks to a definite place, scratches and pushes out the sawdust to make a hole sufficiently large to

---

[1] Watson, J. B. *Behavior, etc.*, pp. 190–91.

> squeeze through, enters and reaches the food. The total time of success will vary (7.04 minutes — 17.65 minutes). On the second trial, which may be given immediately after the first (but the time of success of the second trial will vary with the method) we find, as a rule, an enormous decrease in the number of reflexes. The activity is more confined, i.e., the area covered by the animal is less and what area is covered is covered less intensively (time, 1.69 minutes — 7.20 minutes). On the third trial the time is still further decreased (.48 minute). At the fourteenth trial the time is reduced to .11 minute.

From this account of the behavior of the white rat we note that the major part of the total time required by the animal in the initial trial to reach the food is given over to the making of all manner of random, useless, and irrelevant movements (for example, stopping to clean the paws) which do not in any way advance it directly toward the securing of the food in the cage. And not only does it make random movements of this sort, but it also repeats and re-repeats them many times, just as the human learner, when endeavoring to 'take apart' or 'put together' a mechanical puzzle, will time and again repeat a false series of movements which he has tried several times already.

Learning to open or enter a puzzle box quickly is a matter of reducing to zero the number of such useless movements. In the first attempt, as indicated in the experiment with the white rats, the number of trial-and-error movements is very great. In the second attempt (in this particular experiment) there are far fewer errors and a more restricted range of activity. Complete learning has taken place when the animal proceeds at once and without error to the goal. In the case of the white rat the attainment of this perfection of response came after thirteen trials, the animal reaching the food on the fourteenth in a little more than five seconds. On the whole it appears that the rat stands relatively high in the list of animals in its ability to link up bonds in motor learning.[1]

---

[1] Watson says: "The statement is often made and is probably true that

The trial-and-error method is not an economical method of learning. It is slow, tiresome, and at many points aimless. It requires the release of far more nervous and muscular energy than do higher types of learning. It is a blind, hit-or-miss endeavor to obtain certain results. Nevertheless it has doubtless been the method of learning that has played the chief rôle in the development of the human race up out of savagery. Before man was a reflective being, capable of retaining free ideas of past experiences, he must have been a chance learner, stumbling now upon this, now upon that discovery.

The process of forming motor habits. One of Thorndike's experiments with chicks may be used to illustrate the maze method of studying the formation of motor habits in non-human learners. A number of chicks, six to twelve days old, are kept for some time in the yard *YY*. One of them is subsequently taken from the brood and placed alone at *A*. In this case the instinct to satisfy hunger is not the determiner of the chick's action, but rather its instinct to escape from the solitude of *A* and rejoin the other chicks at *YY*. Its immediate responses on being put down at *A* include run-

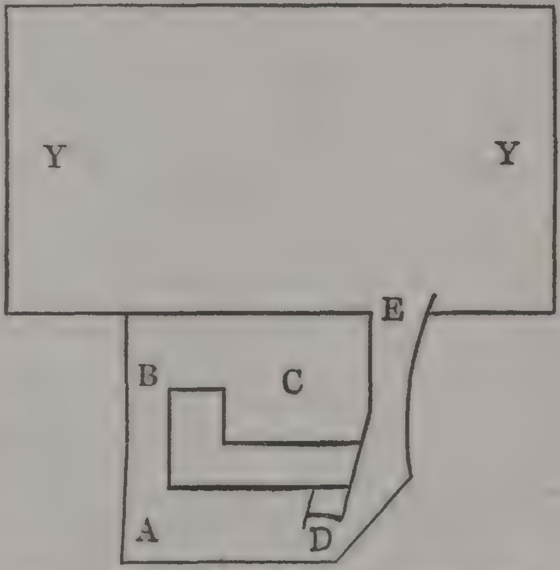


FIGURE 10. A MAZE USED WITH CHICKS

the monkey, with his superb eye-hand coördinations, can form habits of manipulation much more quickly than any of the other animals. . . . It is probable that the raccoon stands next to the monkey, and after him the porcupine and the cat. Probably the dog should appear next, yet the rat is extremely apt in forming simple habits of manipulation. . . . The guinea pig and rabbit are clumsy and the bird class as a whole is notoriously poor in acquiring acts of skill."

ning aimlessly about in the passage way, jumping at the confining walls and making calls of distress. Running to *B*, and thence to *C*, gives no satisfaction; neither does running to *D*, nor back again through *A* and *B* to *C*. Only when it chances in its blind running about to go to *E* is it rewarded with the desired outcome. On subsequent repetitions of the experiment, the chick runs and jumps about less and less, finally reaching a point where being confined at *A* results in immediate and direct running to *E* without error. Of two chicks that formed this particular association between the *A*-situation and the *E*-response, one averaged approximately three minutes in the first five trials, and the other about four minutes. After several repetitions of the experiment, however, both chicks came finally to escape from *A* to *E* within the brief period of five or six seconds from the instant of their being deposited at *A*.

Similarly with the more involved Hampton Court Maze (Fig. 9). Watson reports the results of four normal rats learning to thread this maze. In their early trials, he states, they ran over every square inch of the entire labyrinth, entering and reëntering the blind alleys time after time and only succeeding in reaching the food chamber after numberless trial-and-error attempts. On the average, 29 minutes were required for the first successful trip, but by the end of the thirtieth trial this average time had been reduced to about thirty seconds. Thus, whatever the nature of the experiment, whether it be with the problem box or the maze, and whether the animal used be a rat or a chick or some other, the general process in the formation of motor habits is always the same. There are ever the same aimless and random movements, and always the gradual dropping off of such movements as the number of trials increases, until the animal at length arrives at whatever proficiency is sought by the experimenter or of which its organism is capable.

What are the fundamental factors in the trial-and-error method? If we attempt to analyze the method of trial and error we shall find that it has at least three outstanding features.

First, the learner is unable to foresee what movements are the essential ones to make. Consequently, in the cases of the maze, the correct route can be come upon only by trying out all possible paths until the correct one is found. Similarly, in the case of the problem box, the specific and sequential movements which will permit entry to or exit from the box cannot be forecast. The animal runs hither and thither, and fumbles about a great deal with the fastenings, until the correct combination of movements is discovered. (Thorndike's *Law of Multiple Response.*)

Second, the animal learner is possessed of no capacity to meditate upon a situation, to reason out its responses, and in general to retain and make use of ideas of any sort.[1] Thus, the fact that the animal has already traversed once a given blind alley has often no effect upon its subsequent reaction when it runs again into the same alley. Similarly with the problem box: rational envisaging of the fastenings of the door is utterly beyond the range of possibility on the animal's part.

Third, in the acquisition of motor habits the animal must be actuated by a strong incentive to obtain results. Ordinarily, as we said, the desire for food is the incentive. When an animal is in a good healthy condition of hunger (not starvation) it must either 'try something' or else remain hungry. The whole strength of its instinctive readiness for satisfaction is opposed to idleness and 'set' toward vigorous and continuous activity. The same 'set' is the incentive, whatever the reward to be achieved from successful performance — the satisfaction of food, of companionship, of avoidance of punishment or annoyance, etc.

In other words, like human beings but without their capacity to weigh and choose, animals seek satisfaction and avoid its opposite. If the thirst for satisfaction be made sufficiently keen, through arbitrary deprivation at the hands of the experimenter, they will tend the more actively and zealously to achieve it. Thorndike has named this tendency to seek satisfaction the *Law of Readiness*, and defines it thus: "When any conduction unit is in readiness to conduct, for it to do so is satisfying. When any conduction unit is not in readiness to conduct, for it to conduct is annoying. When any conduction unit is in readiness to conduct, for it not to do so is annoying."

---

[1] There is some evidence that under certain conditions the lower animals do show signs of the mediation of ideas, but the most of their motor learning is explainable in terms of the direct reflex bonding of specific situations with specific responses.

Similarities between animal and human learning

(1) The method of trial and error is found in both types of learner. In the preceding paragraphs we have been concerned with a discussion of the technique of animal experimentation, and some of the conclusions which the comparative psychologists have drawn from their laboratory studies. We now turn to a consideration of certain similarities and differences between the animal and human learner.

In the first place, we conclude that both animal and human learners make use of the method of trial and error in the building up of motor habits. The essence of this method, as we said, is the random, unpremeditated trying, now of this, now of that move, always under the lash of a strong incentive, until a definite series of movements which lead to satisfaction is come upon. Compare, for example, the human process of learning to keep two balls in the air, or to walk, or swim, or skate, or ride a bicycle, or pitch a ball, or to control the tension of the vocal cords in singing, or to hit a 'bull's-eye,' or to write — with the animal process of learning to manipulate the fastenings of the door of the problem box or to thread a maze. Not being in a position to represent consciously the specific controls and coördinations that will lead to the desired end, the human learner is compelled, in very many situations which involve neuro-muscular adjustments, to do as the animal does — try out all sorts of moves before he stumbles upon the correct one.

An interesting study has been made, by J. H. Bair, of learning to move the ears. Ordinarily the ears move involuntarily when one raises his eyebrows or when he smiles broadly. Bair's problem [1] was to endeavor to isolate the process of moving the ears from its ordinary connection with these two larger muscle groups. Only through a long process of trial and error was he able to attain skill in this feat, and no amount of observing another perform it, or of reasoning about it, could be of assistance to him. Just as the animal jumps about aimlessly in the puzzle box, one 'works in the dark' in attempting to segregate a motor series of this sort from its complementary group.

Some maze-threading experiments have been performed [2] with the rat, with the direct purpose of comparing the relative progress in learning of blindfolded human adults, children, and blind white rats. In general the conclusions were twofold: (1) that the rat took less absolute time than the human learner, but (2) that it was slower in eliminating the useless movements than were its human competitors, thus indicating the presence in the latter of memory processes and reasoning.

(2) **The best results from the learning process accrue when it takes place under strong incentive.** Every one knows that the trainers of circus and other performing animals use the whip (punishment) as a common incentive. It has no doubt come also within the experience of the student that household animals — especially the cat and the dog — must be rewarded for their attempts if they are to be taught to jump through a hoop or over a stick, or to 'beg' or 'speak,' etc. Of their own accord, they would never practice these accomplishments. If censure and punishment for failure to respond go along with the reward

---

[1] Bair, J. H. *P. R. Mon. Sup.*, 1902, No. 19.

[2] Hicks, V. C., and Carr, H. A. *Journal of Animal Behavior*, vol. 2, p. 43.

of some fine morsel of food and words of encouragement for the desired responses, the incentive is obviously stronger.

In the case of the child learner, the incentives to progress are often more remote, or at least may be more spiritual than that which suffices for the animal. Dewey's insistence, for example, that school work must be so arranged as to challenge the *problem attitude* illustrates this principle that the satisfaction of a real feeling of need is the strongest incentive a learner can have. The whole doctrine of interest is involved here. What satisfaction can there be to the pupil in the performance of what Thorndike terms "mere serial intellectual gyrations accomplished slavishly and mechanically"? On the other hand, provide a child with an incentive[1] whose genuineness he can feel and respect, and you have aroused his desire to get to the bottom of the problem.

Even the adult learner in the psychological laboratory, as W. R. Wright[2] has shown, achieves quite different results when learning under definite incentive from those achieved without particular motivation. When, for example, a subject is given instructions to this effect: "Here is a dynamometer; you are to work with it as hard and as long as you can," he does not do so well as he does when directed to perform with the dynamometer some specific task. Similarly, when the subject is instructed to attempt repeatedly to reach a standard that he is convinced through initial practice he cannot reasonably expect to attain, he falls off notably in achievement. Other illustrations of the influence of *bona-fide* incentives upon the earnestness of human beings are to be seen in the herculean and sustained efforts which men will put forth to accomplish whatever purposes in life they may have set before themselves. Without incentive, responses in both human and animal become tardy, passive, lackadaisical, and ineffective; with incentive, they become prompt, active, wide-awake, and effective.

---

[1] The word *incentive* is here used in its broadest sense, to include *motive*.

[2] *The Psychological Review*, vol. 13, pp. 23–24.

(3) Learning of a complex series, for human and animal, consists in the building up of certain simple habit-arcs. We have already likened the formation of complex responses in the human learner to the forging and connecting up of a chain whose links are simple habit-reflexes. (See analysis of the typewriting experiment, page 68.) The testimony of the comparative psychologist is to the effect that the formation of complex motor habits in animal learners is similarly a process of building up many simple reflexes, which are linked up in series in such manner that when the first one discharges it liberates the entire series. Take, by way of illustration, the rat learning to thread the Hampton Court Maze (Fig. 9). Viewed as a completed action, the process appears to be a unitary performance; but upon analysis it becomes evident that the animal that has learned to thread the maze successfully has developed a series of simple and definite habits, which control its movements at every point in the maze where an error of turn is possible. In the early trials the animal runs into blind alleys as commonly as into communicating alleys. In the final stages of the learning process, however, at each intersecting way it invariably enters the appropriate communicating alley; i.e., it has formed in connection with each intersection of ways a specific habit-reflex which causes it to take the right turn. The sum total of all these arcs, discharging in orderly series, results in the animal's threading the maze without error or loss of time in the process.

(4) Initial trials in motor learning require much more time than do succeeding trials. This principle is shown to be operative likewise both in human and in animal learning. As an illustration of it in the former type, consider the typewriting experiment described in Lesson 4. It will be recalled that a subject who had never operated a typewriter was confronted with the problem of inserting a sheet of paper and reproducing a short sentence as quickly and accurately as possible. The performance time was fifteen minutes and five seconds, most of which was consumed with 'trial-and-error' attempts at insertion of paper or with manipulation of shifts and adjustments. The movements were for the most part random and uncoördinated. Compare with this the performance of white rats in threading the maze. In a given maze in which the actual distance from the entrance to the food box is some ten feet, by the shortest route, the rat may on its first trial run several hundred feet — say, eight hundred, or more — before it finally blunders into the food chamber. After fifty trials, however, it may not take a single useless step.

Watson publishes a curve showing the total average time and distance run on each of seventy trials by twenty-seven white rats. In the first eight or nine trials there is shown to be an enormous drop in both time and distance. In the first trial, approximately six minutes were required to thread the maze, while in the eighth and ninth this time had been reduced to considerably less than one minute, dropping thereafter with fluctuations to perhaps fifteen or twenty seconds after the fiftieth trial. The distance curve parallels almost exactly the time curve. At the seventieth trial the animals reached apparently the physiological limit of training.

Star-tracing and mirror-writing experiments performed by human learners in the laboratory indicate a similar rapid drop in the time curve, with succeeding trials beyond the initial trial. Both the human and the animal learner, when confronted with a situation in the solution of which they are unable to forecast the necessary movements, respond by making a great number of aimless and random movements which, however, in succeeding trials, sharply decrease as the proper neuro-muscular bonds are knitted together.

(5) There is an optimum distribution of trials in both human and animal economical learning. The comparative psychologist is in a somewhat better position to test the effects of various methods of training upon animal learning than are teachers in testing the effects of their methods

upon the learning of children. We now have, however, data from both animal and human learners as to the optimum number and frequency of trials in building up bonds as economically as possible. The testimony that the animal psychologist offers in solution of the problem: What number of trials a day should be given an animal in which it is desired to induce a motor habit in a minimum amount of time, i.e., with a minimum number of trials? is that, in general, a few trials per day are more economical than a large number. Three to five trials a day are found to be very uneconomical, in that they necessitate a much greater gross number of trials to stamp in the habit. Watson quotes Ulrich as finding the most economical of all arrangements to be one trial every two days.

What now is the testimony of the human psychologist in the same connection? In general, for sorts of learning comparable with animal learning in which motor coördination is involved, his testimony is similar: usually trials at daily or longer intervals are more profitable than concentrated periods of practice. Murphy concludes, from his study of javelin throwing,[1] that "learning periods can be distributed by giving alternate days practice, and even weekly practice without any loss in learning."

(6) **New situations are responded to by both types of learner like old situations most like them.** What is the effect upon the learner of a situation somewhat similar to one to which he has previously learned to respond? Will the habits formed be usable in a slightly different situation, or must the subject form specific bonds in each new situation? In the case of the animal one would conclude that there would be a decrease in the amount of time required to escape from a second maze, after it had learned to thread a similar one rapidly. This expectation appears to be confirmed by many of the experiments that have been performed. Yerkes, working with dancing mice, found that an

---

[1] H. H. Murphy, "Distribution of Practice Periods in Learning"; in *Journal of Educational Psychology*, vol. VII, p. 16, no. 150.

animal not previously trained in a preliminary maze required 19.7 trials before succeeding in threading a maze (*A*) without error. On the other hand, animals given a preliminary training in another maze (*B*) made a successful trip through (*A*) on the seventh trial. Another investigator,[1] experimenting with white rats, found that rats previously trained in preliminary mazes required but 5.72 minutes to escape from the test box, while rats not previously trained required 40.14 minutes to make their initial escape from the same test box.

Some experimenters, however, report that preliminary habits acquired by training persist in the new situation to the extent of interfering with the formation of new responses. This has been found to hold true at least with pigeons and squirrels. This principle that to a new situation the learner will respond by making the movements which were learned in another situation that resembles the new is called by Thorndike the *Law of Assimilation* or *Analogy*. He says:

> There is no arbitrary *hocus-pocus* whereby man's nature acts in an unpredictable spasm when he is confronted with a new situation. His habits do not then retire to some convenient distance while some new and mysterious entities direct his behavior. On the contrary, nowhere are the bonds acquired with old situations more surely revealed in action than when a new situation appears. The child in the presence of a new object, the savage with a new implement, manufacturers making steam coaches or motor cars, the school boy beginning algebra, the foreigner pronouncing English — in all such cases old acquisitions are, together with original tendencies, the obvious determiners of response. . . .

Yoakum found in his experiments with squirrels that squirrels trained to open box 1 and box 2 are at a disadvantage as compared with untrained animals when they come to learn box 3. " Boxes 1 and 2 require scraping, butting up the latch with the nose, etc. These acts were carried over to box 3; consequently the animal lost time in trying to open box 3 by persisting in movements organized to meet other conditions." It would seem then that, if the animal is to profit in the new situation from past experience, both the old and the new situations must be very similar in nature, otherwise the interference noted will hinder the formation of the new bonds.

---

[1] Richardson, *Psychological Monographs*, serial no. 48.

A practical human phase of this principle of analogy or assimilation may be illustrated by the skill with which the repairman sets about locating 'trouble' in an automobile or in a watch, or any other complicated mechanism. To the new situation he brings the fruits of his past experiences with automobiles, or with watches. He may never have worked upon an automobile or a watch of this particular make, but he sets confidently and efficiently about looking for 'trouble' by virtue of the skill which by analogy he possesses from similar past situations. But for this principle of human learning it is hard to think how one could ever develop new responses. It is only in terms of the old that the new is made to possess meaning.

In the learning experiments performed in the laboratory and in the classroom with children this same principle is found within certain definite limits to be operative. In a subsequent lesson (Lesson 17) we shall inquire more specifically into this much mooted matter of transference and interference of learning. Suffice it to say at this point, however, that in similar situations, identical elements characteristic of one will be found to carry over to the other, both in human and animal learning. Thus, having learned to write English words, I am able the more quickly to learn to write French words, by virtue of the common element in both situations; i.e., the motor connections involved in the formation of the individual letters. Similarly, the animal that has learned to manipulate box A will learn to manipulate box B more rapidly, provided the fastenings of both boxes are very similar in operation. If, however, as Yoakum's experiments with the squirrels showed, the fastenings are dissimilar, then the presence of previously formed connections may actually delay the process of learning to manipulate the new fastenings. In a similar way the human learner may be hindered by the habits formed in past experiences in the mastery of a new series.

Differences between animal and human learning

In the preceding paragraphs we have been discussing certain common factors in all motor learning — animal as well as human. Notwithstanding these striking similarities, however, animal learning is quite at variance with human learning in certain very significant respects. To a consideration of these differences we now turn.

(1) Animal learning is limited to a very restricted range of sensori-motor responses. We may summarize animal learning in general by saying that it is limited to the direct connecting of some gross body response with a situation immediately present to the senses. Learned response in an animal can only be initiated by sensory appeal of some sort or another. There is no evidence to indicate that the animal can retain *ideas* in the connected series of arcs which discharge as it runs through the maze, or are operative in its entrance to or escape from a problem box. None of the lower animals appear capable of learning satisfactorily to react to a new situation save through the multiple process of trial and error. It is commonly agreed that an index of intelligence in an individual is his ability to adjust himself to a new situation through the bringing to bear of past experience, retained in the form of 'free ideas,' upon the new situation. This representative capacity has been found wanting [1] in animals — at least, relatively so. On the lower levels of habit formation the animal makes, on the whole, a fair apprentice; but on the higher levels of associative learning, involving judgment, reasoning, abstraction, he is helpless because of this absence of capacity to retain free ideas, and hence of reflective consciousness.

---

[1] The capacity to retain some sort of vivid representation of past experience is undeniably present in the dog, for example, which mourns the absence of his master, or which waits expectantly for the recurrence of the situation: "Go, fetch the stick!" Even here, however, it is open to question whether this evidence of the existence in the dog of some form of psychic memory is of any great significance in the learning process.

It should be repeated, however, that much of the motor learning of children is no more reflective than the characteristic form of animal learning. The acquisition of speech habits, walking, or skill in pitching a ball or wielding a bat, is a slow process in which, as we have seen, trial and error play important rôles. Conscious imitation, however, early develops and comes soon to exert a directing influence in the process of acquisitions of a motor nature. This imitative response is reinforced by the instincts — notably play, general physical and mental activity, and curiosity — which tend to urge the human child to new and ever new triumphs of learning or of acquisition, while the animal, subject to fewer instinctive urges and organized nervously on a simpler scale, reacts only to such situations as are fraught with necessity, in order that by reaction it may secure the physical satisfaction which accrues, or avoid the physical annoyance that its failure to respond will create.

Ruger [1] has gone a step further in the investigation of the employment of trial-and-error methods in human learning, and has shown that adults, as well as children, often attempt to unravel new situations by blind trial and error. He says, in describing the process of learning to manipulate mechanical puzzles:

> The behavior of human subjects in the puzzle test . . . showed many of the features usually accredited to the behavior of animals in contrast with that of human beings. The times for repeated successes in a number of cases remained high and fluctuating, the time for later trials in a given series being often greater than that for the first success. Acts which made no change in the situation whatever were at times repeated indefinitely and without modification. In successive trials of a series, after an essential step toward a solution had been performed correctly, it was reversed and done

---

[1] Ruger, H. A. "The Psychology of Efficiency"; in *Archives of Psychology*, June, 1910.

over several times with irrelevant movements, interspersed before the subject passed on to the next step. . . . In practically all of the cases random manipulation played some part and, in many cases, a very considerable part in the gaining of success.

In substance, then, while human beings undoubtedly employ the wasteful method of trial and error in the solution of a considerable number of the novel problems that confront them, the animal is probably *limited* to this method of reaction.

(2) **The absence of language is an important factor in the delimitation of the animal's possible range of acquisition.** However similar the animal may be to the human learner in any given respect, it is forever differentiated from man by its utter lack of ability to use a systematic language. This means that the animal has no means of substituting what we may call 'word habits' for 'body habits': its level of life is necessarily carried on at the low estate of gross physical response. Conscious representation by means of thought is impossible, since there are no words in which to represent thought centrally. The realms of abstract knowledge, of conception and reasoning, of judgment and choice, are totally unattainable by the animal, inasmuch as these processes are conditioned either upon verbal presentation or representative imagery.

(3) **The animal learner is unable to abstract from concrete experiences general principles which will help in subsequent experiences.** We have said that the animal is unable consciously to represent past movements and their results. Hence conscious control of movements becomes impossible. This fact is further emphasized by another characteristic of animal learning; viz., its inability to analyze out a new situation and discover in it elements with which it may already be acquainted through past learning experience, except as we have seen in simple manipulative operations that have striking similarities.

This helplessness of the animal in the face of a novel situation may be illustrated from one of Thorndike's experiments with cats. He constructed a problem box, the front side and cover of which were formed by bars placed an inch apart. The door could be opened only after a button on the inside was turned from a vertical to a horizontal position. A hungry cat was placed inside the box and a bit of fish at a little distance outside. Immediately the olfactory stimulus initiated the multiplex random movements characteristic of trial-and-error learning. It ran aimlessly about the box, biting and clawing at the bars and at any loose object, finally chancing to turn the button and so escape to the fish outside. After a large number of repetitions of the experiment it became so skilled in the performance that it pushed the button immediately upon being confined in the box. But now let a loop or bolt be exchanged for the button and the cat is at once helpless. Its previous association with the box-button-fish situation is of relatively little assistance to it in reacting promptly to this new phase in the situation represented by the substitution of the bolt or loop. It must go again through the elaborate process of trial and error before it can secure the satisfaction embodied in the food outside. The animal does not, in other words, bring to bear upon the solution of the new situation the retained consciousness that "escape is to be had by manipulating a fastening." It is only through random clawing all about the box that it chances to slide the bolt or pull the loop and escape.

In contrast with the animal, the human learner, compelled though he often is to make use of the same trial-and-error methods of the animal, is able to abstract from individual experiences general principles of procedure which, in the form of free ideas, as we have seen, he is able to retain and bring to bear interpretatively upon new situations. Past experience in the human learner has been raised to the level of reflective consciousness. Let a human being be confronted with any problem comparable with that with which the cat in Thorndike's experiment was confronted, and he is likely to make similar random and ineffectual movements in an attempt to solve it. But change the nature of the problem in a way comparable with the substitution of a bolt or a loop for a button, and he will be conscious of the change and will concentrate upon mastering it.

Suppose, for example, a person who has learned to operate a typewriter having a standard keyboard is given the problem in the laboratory of writing with a machine the arrangement of whose keys has been altered. Forthwith his previous experience with the standard machine comes to his assistance and he is still able to write, though of course less rapidly than before. The situation: 'wanted, *a*,' leads to the impulse to strike the first key in the middle row. When this movement fails to give the desired response, the manipulator does not strike aimlessly key after key until he chances to strike the proper one; he merely concentrates for a few seconds upon the new keyboard until he has located *a*, and then promptly strikes it. The human learner, in other words, possesses the capacity of retaining definite ideas from previous experience which operate to reduce to a minimum the necessity for blind trial-and-error methods in mastering new situations.

(4) **Imitation, which plays an important rôle in human learning, is of relative insignificance as a method in animal learning.** The experiments in the laboratory upon animal learning make it evident that the animal is able to profit in general but very little, and in many cases not at all, from imitation either of the experimenter or of another animal that has already learned to open a box or thread a maze successfully. Thorndike, for example, experimenting with monkeys, found that waiting until the animal was watching him and then, with much emphasis of movement, opening the box slowly, failed to give the monkey any definite hint when it attacked the problem immediately afterward: it went at it in the ordinary trial-and-error fashion. When he substituted another monkey that had previously learned to open the box, negative results were again obtained: the

example of the trained animal was lost upon the untrained one. Watson's experiments with monkeys exactly confirm Thorndike's in this respect, they "being able to form very quickly by their own unaided efforts habits of manipulation, but so far as our observations went they were entirely uninfluenced by tuition." [1]

Similar conclusions with reference to the insignificant part played by imitation in animal learning have been drawn by various investigators who have used cats and dogs as subjects. Yerkes, experimenting with the dancing mouse, found little if any evidence of the operation of imitation. In one experiment he placed a trained mouse in a box from which the only means of escape was a ladder which must be climbed. The trained individual performed before untrained mice many times without the latter evincing any disposition to climb the ladder.

Other experimenters, however, believe they have found evidence of the operation of imitation in certain animals: in monkeys (Hobhouse); [2] in cats (Berry); [3] in raccoons (Cole); [4] in white rats (Berry); [5] and in birds (Porter).[6] It should always be borne carefully in mind that comparative psychology as a scientific study is a recent off-shoot of psychology, and this explains the reason why it not infrequently happens that workers in this field find their results somewhat at variance. In general, we may conclude that, (1) while the results of experimentation upon the rôle of imitation in the learning of animals are not at all points harmonious, (2) it is certainly true that imitation in animals is by no means universal nor a very significant method in such processes of learning as have been studied in the laboratory. As to the part it may play in the adjustment of the various animals to their natural habitat, we have of course no definite means of determining at present.

---

[1] *Mind in Evolution.* New York, Macmillan, 1901.

[2] *Ibid.*

[3] In *Journal of Comparative Neurology and Psychology*, 1908.

[4] *Ibid.*, 1907. [5] *Ibid.*, 1906.

[6] In *American Journal of Psychology*, 1910.

As opposed to the animal learner, the human learner makes perhaps greater use of imitation than of any other method of acquisition. From the very first articulate sounds which it makes, the child is an imitator of somebody else. At first, and intermittently always a reflex imitator, the child comes soon consciously to observe the behavior of others and to fashion his own responses accordingly. In the acquisition of sensori-motor skills of every sort, he will progress fastest if he has a teacher whom he can imitate or whose products he may copy. This imitatee may be magician or machinist, parent or playmate — the child is a proficient and earnest imitator.

(5) **The plateau phenomenon, often found in human, does not exist in animal learning.** One of the outstanding characteristics of human acquisition of motor habits is the so-called 'plateau,' which appears frequently in the curves constructed to portray graphically the progress of learning. In Lesson 7 we shall inquire more specifically into the significance of this plateau level, where little or no progress over a considerable period appears. We may anticipate a bit, however, by remarking that in such experiments as Book's on learning to typewrite it is observed that the curve drops rapidly and abruptly at first — indicating that learning during the first few units of practice gives greater returns than at any time subsequently — then more and more slowly until the plateau stage is reached, where the learner may remain for a considerable period. Later on in the process, however, he begins again to progress, and the curve declines gradually until, provided he continue for a sufficiently long period, the performer reaches his physiological limit. Various explanations of the plateau level have been advanced, and we shall make due reference to them subsequently. In not all human learning of a motor nature, however, has the plateau been found to exist.

Animal learning, whatever may be the explanation of the plateau in human learning, manifests no such phenomenon. The curve of animal learning drops rapidly at first and then somewhat gradually, with irregularities of course, until the maximum of achievement is secured. Watson explains the plateau in part as due to weak or artificial incentives in the human learner. He says:

> When an animal has to work or remain hungry; to make a correct response at an alley or be punished, etc., the incentive may be said to remain at a maximum. . . . If a man's food . . . were dependent upon acquiring skill in a certain line . . . such resting-places and plateaus would in all probability disappear from his learning curves.

In the next lesson we shall turn aside from a further discussion of the nature of the learning process to a consideration of the general subject of learning curves, which we shall find it needful to understand before proceeding further.

QUESTIONS AND PROBLEMS

1. Using References 3 or 5 (below), report upon some definite maze or puzzle box experiment upon the learning process in animals.
2. Write out a brief summary of each of the following laws or principles of Thorndike: Multiple Response; Readiness; Law of Exercise; Law of Effect. (Reference 4.)
3. Make a list of as many human motor habits as you can that depend for their building up in considerable measure upon trial and error.
4. The statement is made repeatedly in Lesson 6 that the trial-and-error method is made use of by both human and animal learners. Wherein then does the acquisitive capacity of the human excel that of the animal learner?
5. What are some valuable general incentives to school work? What are some incentives that fail to enlist the enthusiasm and effort of the pupil-learners?
6. Write out a concrete illustration of the influence exerted by free ideas upon the solution of an unfamiliar problem.
7. Make a list of human acquisitions which in large measure depend upon imitation.

SELECTED REFERENCES

1. Freeman, Frank N. *How Children Learn*, chapter 8.
2. Breese, B. B. *Psychology*, pp. 401–12.
3. Thorndike, E. L. *Animal Intelligence.* (General Reference.)
4. Thorndike, E. L. *Educational Psychology;* vol. II, *The Psychology of Learning*, chapters 1 and 2.
5. Watson, J. B. *Behavior, etc.*, pp. 92–105; 190–221.

LESSON 7

THE LEARNING CURVE

EXPERIMENTS:

8. *Curve constructing.* You will be in a position after you have mastered Lesson 7 to begin the construction of your own learning curve in the digit-symbol substitution experiments which you started in Lesson 4, and which you should continue for several weeks. Prepare a good-sized sheet of coördinate paper, and lay off on the abscissa the trial numbers and on the ordinate the achievement symbols, beginning in the former case of course with 1, 2, 3, etc., and in the latter with the lowest digit-symbol you achieved. Place the points and draw the curve. As you progress in this type of learning, from day to day, continue to make the daily entries on the graph so that, at the end of twenty or thirty or more days of five practice-trials each, you will have a complete record of the story of the growth of the bonds in digit-symbol learning.

9. *Curve constructing.* In a similar way, start the construction of a curve to show the development of your skill in the card-sorting experiment, which you began also in Lesson 4. As you continue the sorting, from day to day, enter the daily time points on the graph in order that, after you feel that you have reached the physiological limit, you may have a complete record of the learning process for this particular type of acquisition.

10. *Curve constructing.* In a maze-threading experiment, in which rats were the learners, the following were the approximate number of minutes required by them on the average in successive trials to pass through the box:

27 1/2; 10 3/4; 12; 3 3/4; 4 1/2; 5; 5 1/5; 2 1/5; 2 1/4; 2; 1 4/5; 1 3/5; 1 1/4; 1 1/2; 1; 3/5; 2 4/5; 1; 3/4; 4/5; 1/2; 4/5; 3/4; 4/5; 2/3; 1/2; 3/4; 2/3; 3/5; 1/2; 1/2; 2/5; 1/3.

Construct the time curve for the process, indicating fractional parts of minutes by so placing the points on the vertical coördinates as to show fractional parts of them. Thus, 27 1/2 would be at a point halfway between 27 and 28; 1/3 would be 1/3 of the distance between 0 and 1, etc.

The general value of curves. In New York City, between 1900 and 1914 the death-rate for all causes was as follows:

1900	20.6	1908	16.2
1901	19.8	1909	15.9
1902	18.5	1910	15.9
1903	17.9	1911	15.1
1904	20.1	1912	14.3
1905	18.3	1913	13.7
1906	18.3	1914	14.0
1907	18.2		

Such a series of figures as this is not only hard to read, but it is also hard to interpret. A mere glance at it is not sufficient to reveal its meaning. Suppose we arrange it in the following manner:

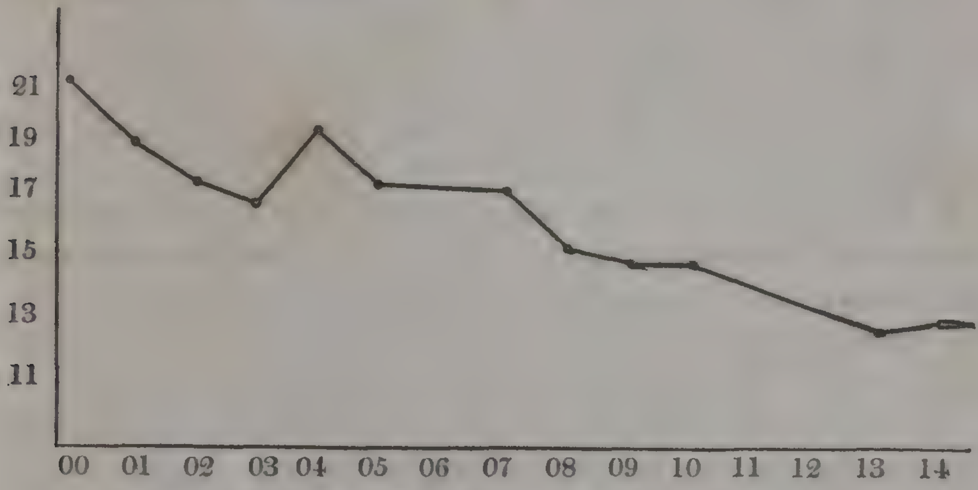


Figure 11. Death-Rate Curve for New York City

Under this arrangement the significance of the data becomes much greater. It is plain at first glance that the trend in the annual death-rate in New York City is downward, that whereas nearly 21 persons per 1000 were dying in 1900, by 1914 that number had been reduced to 14. The arrangement of the data in this graphic way indicates also that the reduction in the death-rate during the years 1900–14 was not uniform. In 1904, for example, the rate jumped from 18 back to 20. Between 1905 and 1907 it remained stationary, falling thereafter somewhat regularly until 1913, when it rose slightly. The public health worker is of course interested at once to find out why the death-rate in New York City was so much higher in 1904 than at any previous time since 1900–01. The curve, in other words, presents a picture of the general progress of a falling death-rate in this particular city. Every variation in the curve reflects some agency at work in the manipulation of the New York death-rate.

Let us look for a moment at a second series of data which gives the total volume of immigration into the United States, by ten-year periods, since 1820:

1820–1830	151,824	1871–1880	2,812,191
1831–1840	599,225	1881–1890	5,246,613
1841–1850	1,713,251	1891–1900	3,687,564
1851–1860	2,598,214	1901–1910	8,795,386
1861–1870	2,814,824	1911–1920	5,305,810

Here again, as in the case of the figures portraying the variations in the death-rate for New York City, the columns of dates and people must be inspected with some care and degree of concentration in order that the student may understand their significance. Let us draw a curve that will show graphically this story of the volume of immigration into the United States as shown in Fig. 12.

We now have a simple picture of the volume of immigration to our shores in the past hundred years. In general, as the most cursory examination of the curve indicates, the number has been on the increase ever since the movement started. Between 1820 and 1870, the immigrants came at a fairly uniform rate of increase. For the next ten years (1871–80) there was no increase. Since 1880 there have been two sharp rises and two equally sharp drops in the number of arrivals. Between 1881–90, and again between 1901–10, they came in greater numbers than ever before or since. In the decades following each of these periods, 1891–1900, and 1911–20, they dropped back almost to a level equal to that of twenty years previous. The student of sociology is interested at once to learn the economic or social causes back of every one of these periods of rise and fall, for here again the same principle is operative: every variation in the curve reflects some agency at work — in this case, in the volume of immigration.

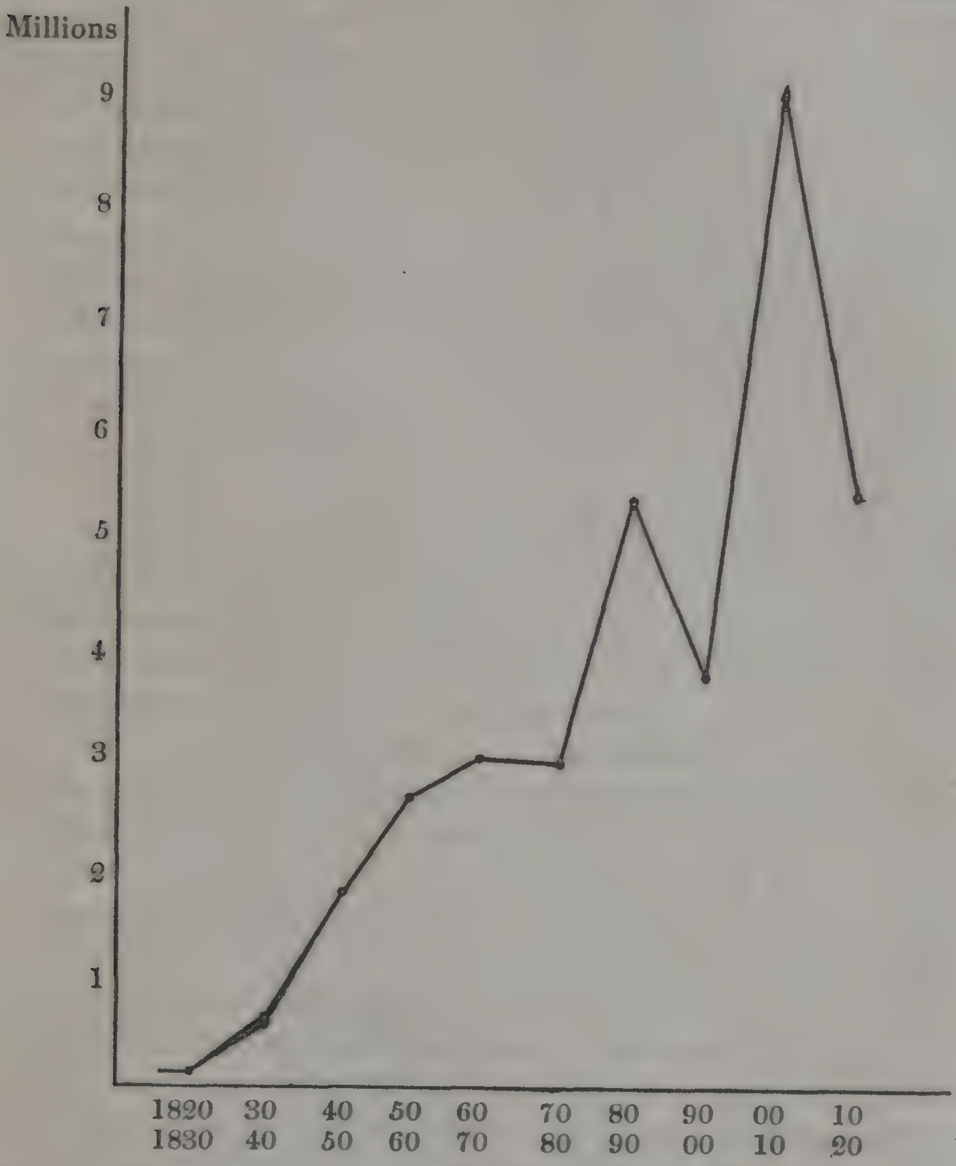


FIGURE 12. IMMIGRATION INTO THE UNITED STATES

So we might continue to construct curves reflecting other data of the most diverse sorts. We might, for example, show in this way the value of imports and exports over a period of years; or the increase in the number of pleasure automobiles in operation; or the perennial budget for public education; or the growth in acreage of wheat; or the growth of the book-publishing industry; of electrically lighted farm-homes; of the per capita consumption of sugar; of the rolling stock of railroads; of deposits in savings banks; of persons owning their own homes; of the tonnage of ocean-going bottoms; etc., etc., to enumerate but a few of the cases in which curves are an abbreviated and striking means of portraying periodical variations of one sort or another.

The use of the learning curve. We may conclude from the preceding illustrations that any activity which extends over a period of time, and which is either increasing or decreasing (or indeed is remaining stationary) in range, may be pictured by a curve so drawn that these variations are clearly reflected. The learning process, by the very nature of its name, is a *process*. It requires time to learn any data, whether they be nonsense syllables, stanzas of poetry, the location of boxes in card-sorting, the symbols for numbers in digit-symbol experimenting, or the trial-and-error maze-threading and box-opening of animals. There are always variations in the rate of acquisition of these and of all other responses. In consequence, the learning process is an activity which lends itself excellently to graphic representation by means of curves.

The experimenter into the nature of the learning process is interested to discover the causes behind the variations in a subject's rate of acquisition, and in working out if possible certain fundamental facts or laws about learning. He finds it also valuable to compare the progress made by one subject in a given kind of learning with that made by another in the same type and under similar conditions. For these purposes the construction of learning curves becomes a matter of practical necessity. Always here, as in the other varieties of curves, a variation in a curve reflects some agency at work which is influencing the learning process.

Constructing a learning curve. In the construction of curves it is desirable that coördinate paper be used, i.e., paper ruled both vertically and horizontally in such a way that the sheet presents the appearance of a large number of rectangular figures identical in size. For most learning curves, one quarter inch squares are very satisfactory. The size of sheet used for plotting a curve will depend upon the number and nature of the data to be tabulated. A convenient size for most learning curves will be not larger than nine by twelve inches. If the two series of units (time and achievement) are considerably less than thirty-six in one case and forty-nine in the other, a correspondingly smaller sheet may be used. There should always be available in the laboratory a quantity of sheets of coördinate paper, cut in two or three different sizes. It is of course possible for the learner to rule ordinary plain paper coördinately, as he needs it, but it will be found a great saving of time, as well as a convenience for comparative purposes, if the specially prepared paper is supplied.

The first step is to draw a line down the left margin, and another to meet it at right angles along the bottom of the sheet; thus:

FIGURE 13. ORDINATE AND ABSCISSA

Since these are the lines along which are to be spaced the two series of data, it will be helpful if we learn their names. The line OX is known as the *abscissa*, and OY as the *ordinate*. The point O may be referred to as the *point of origin*. Let us now see how the data are laid off on the ordinate and the abscissa.

The following figures represent the number of digit-symbols written by J in each of twenty-five practice-periods of one minute each, the same symbols being used as those which you have already learned through the substitution test in experiment 1: 16, 17, 18, 26, 27, 26, 26, 28, 31, 36, 32,

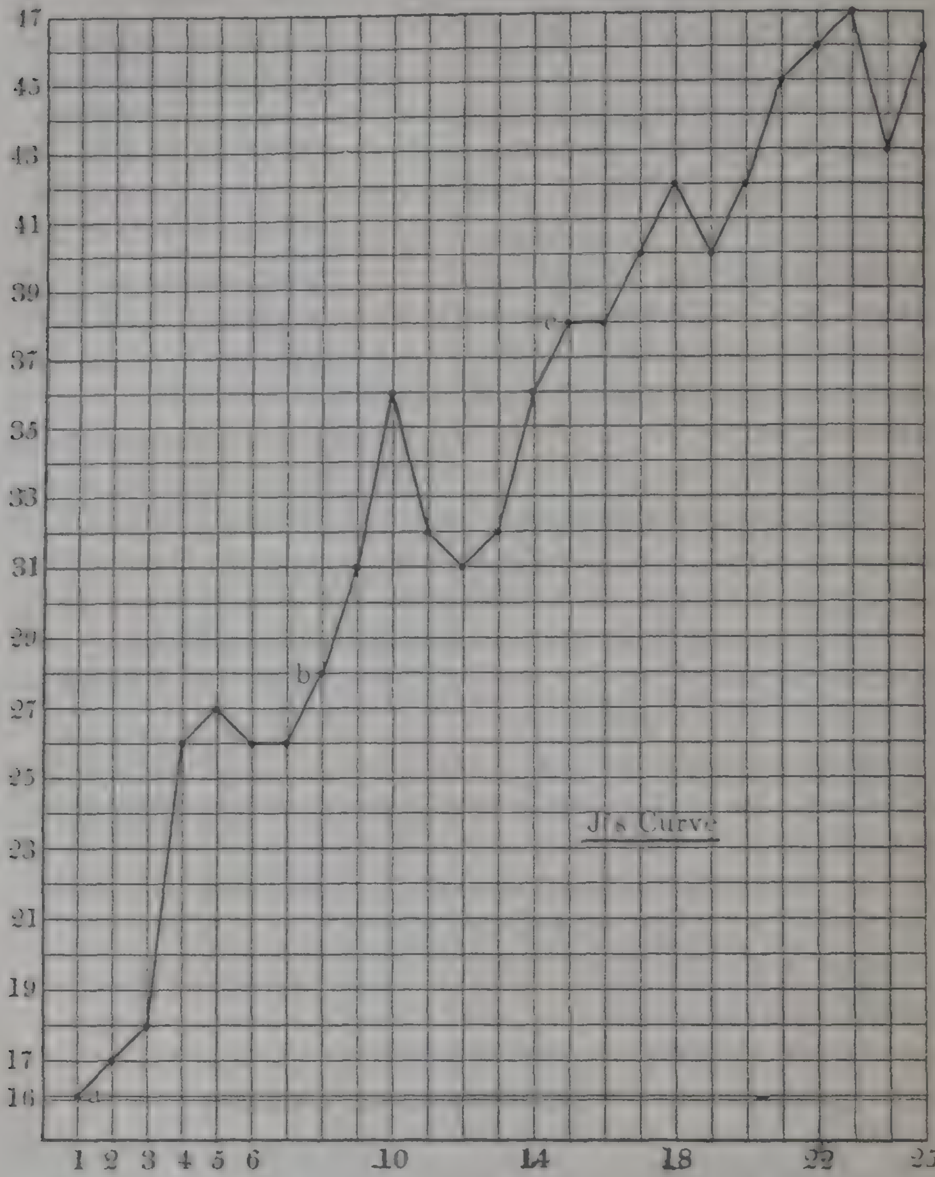


FIGURE 14. DIGIT SYMBOLS WRITTEN IN TWENTY-FIVE PRACTICE PERIODS BY *J*

31, 32, 36, 38, 38, 40, 42, 40, 42, 45, 46, 47, 43, 46. Letting each rectangle along the abscissa represent one minute, and each rectangle along the ordinate one symbol, we may proceed to lay off the units of both orders. Since *J* wrote 16 symbols in the first minute of practice, and did not subsequently fall below that minimum, we may start the notation on the ordinate at 16. Had her lowest number been 10, we must have started at 10. Let us next place a dot at every point on the sheet represented by *J's* performance in successive trials. To illustrate: the first trial resulted in 16 symbols being written. Dot *a* therefore reads: "16 the first minute." The eighth trial resulted in 28 symbols being written. Dot *b* therefore reads: "28 the eighth time." In the same way dot *c* reads: "38 the fifteenth time," etc., etc. After we have placed all the dots our sheet will have the appearance of Fig. 14.

We now have the skeleton of *J's* curve for learning this particular substitution. It remains only to connect up the dots by straight lines.

Fig. 15, representing the curve of progress of *L's* learning, tells us a somewhat different story. The material was the same as that represented in *J's* curve: digit-symbols. Like *J*, *L* started out with sixteen symbols in the first practice-

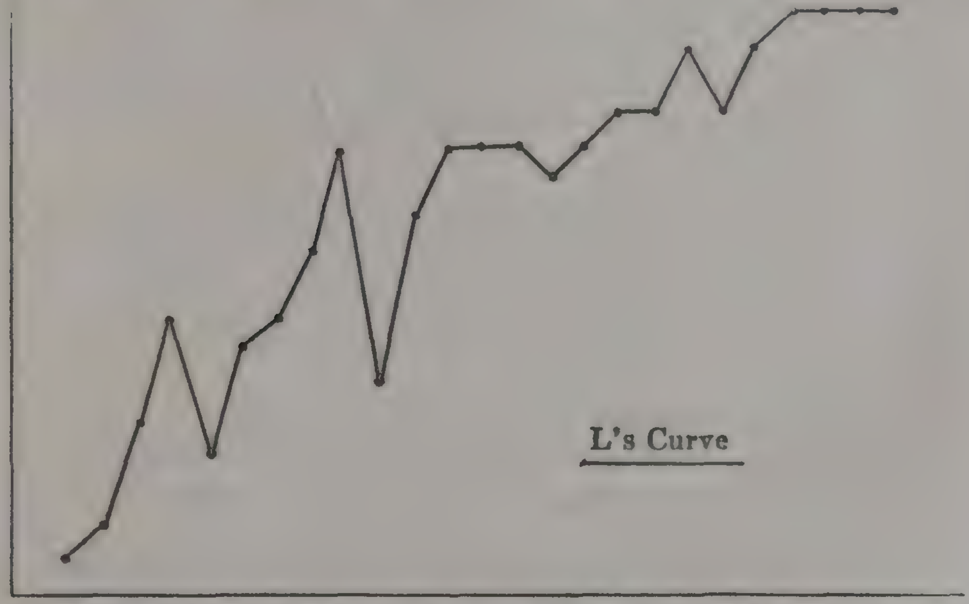


FIGURE 15. DIGIT SYMBOLS WRITTEN IN TWENTY-FIVE PRACTICE PERIODS BY *L*

minute, but instead of improving with equal rapidity in subsequent practice-minutes this subject improved much more slowly, achieving but thirty-two substitutions after twenty-five periods of practice.

Rising versus falling curves. In both the preceding illustrations of learning curves the tendency has been on the whole for the curves to rise, with occasional fluctuations, stand-stills, and even temporary drops. This means simply that given certain constant lengths of time in which to practice a skill, the learner tends on the whole to increase in skill from one period to the next, so that after each succeeding trial he is more proficient than after any preceding one.

Suppose however that instead of fixing the length of the practice period we fix or make constant the amount of material to be practiced. It is then obvious that each succeeding practice will require a smaller amount of time on the average than previous practices. Consequently a curve plotted to show this diminishing factor of time must be a falling, rather than a rising one. There will of course be irregularities here, just as there are in the case of the rising curve where the time is fixed and the material unlimited, but, in general, the progression must be downward rather than upward.

Let us plot such a descending curve. Subject *M* made the following records in the first ten trials of a card-sorting experiment similar to the one described in Lesson 4, five practice-periods per day being given: 50, 35, 35, 32, 27, 30, 27, 26, 24, 25.

In laying off the units for a graph to represent the progress of *M's* learning, we may put the minutes required on the ordinate and the practice numbers on the abscissa. This will give us Fig. 16. Since *M* required 50 seconds to sort the pack in the first trial, we may mark 50 as the highest point on the ordinate. Let us next place a dot at every point on the sheet represented by *M's* performance. Point *a* reads: "50 seconds for the first trial." Point *b* reads: "35 seconds for the second trial." Point *c* reads: "24 seconds for the ninth trial," etc. After we have properly located all the points our sheet will appear like Fig. 17.

We now have the skeleton for *M's* time curve for the

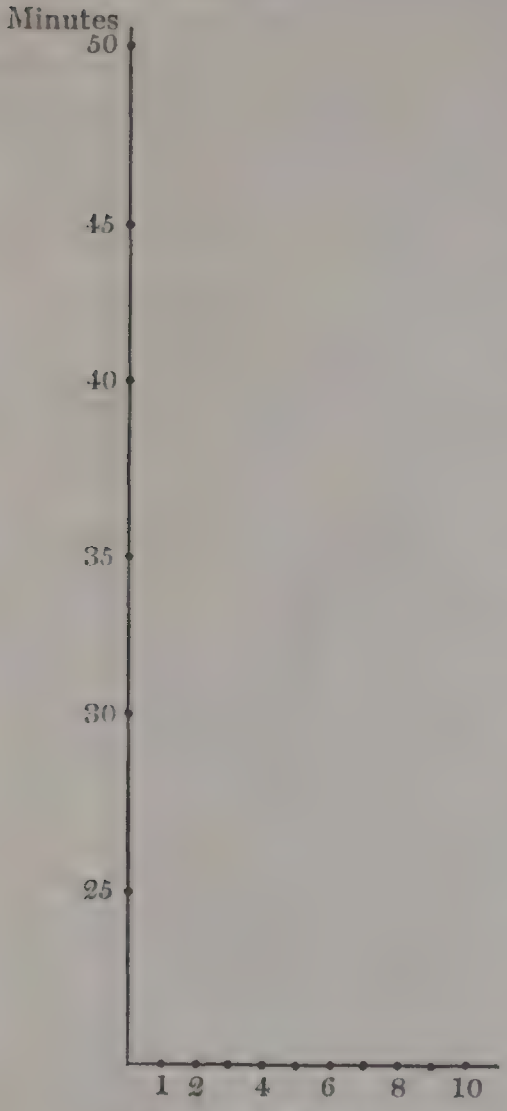


FIGURE 16. THE PAPER LAID OFF

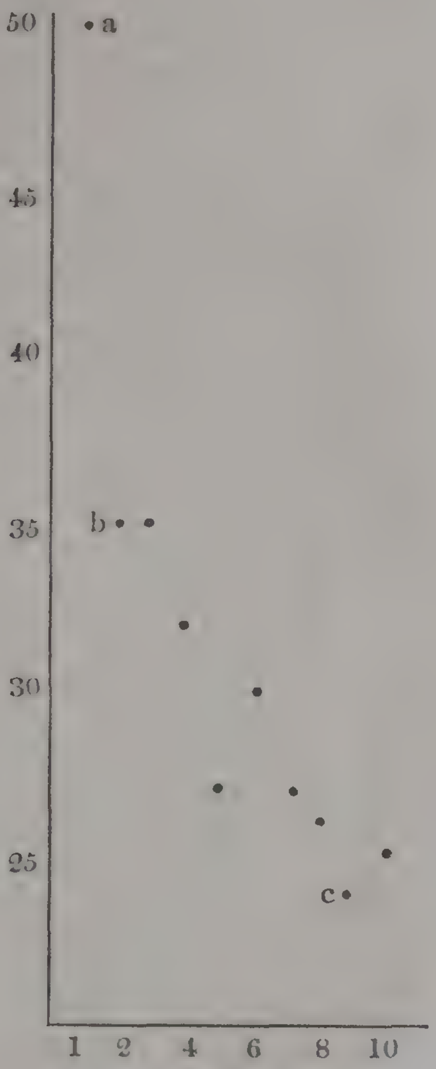


FIGURE 17. THE TRIAL RECORDS INDICATED

early stages of mastering this particular sort of performance. It remains but to connect up the points by straight lines, and Fig. 18 becomes *M's* learning curve for card-sorting.

Fig. 19 represents the curve of another subject in the same kind of learning. The decrease in time for Subject *P* is considerably more rapid than for Subject *M*.

We conclude in general then that a learning curve may tend either to rise or to fall and still indicate gain, either in performance or of time, on the part of the learner. In the former case, the time is the constant and the material the

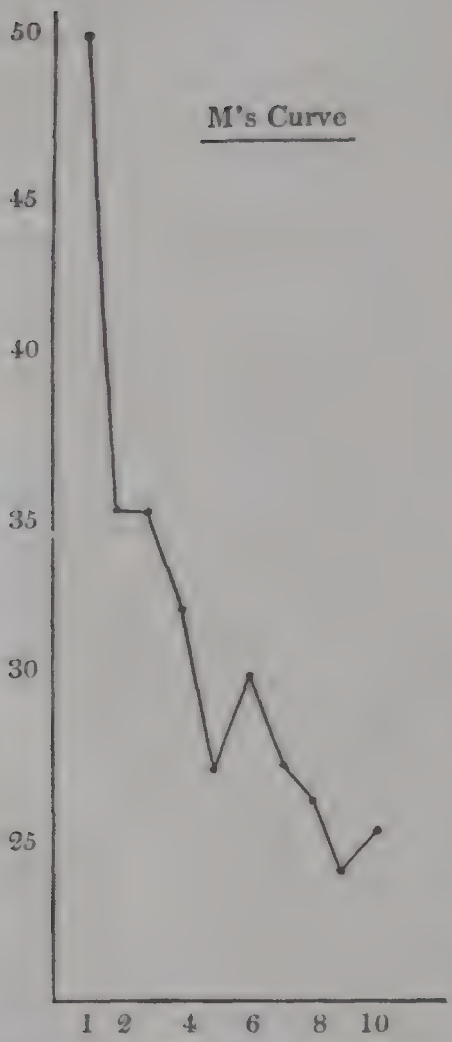


FIGURE 18. THE COMPLETED RECORD CURVE OF *M*

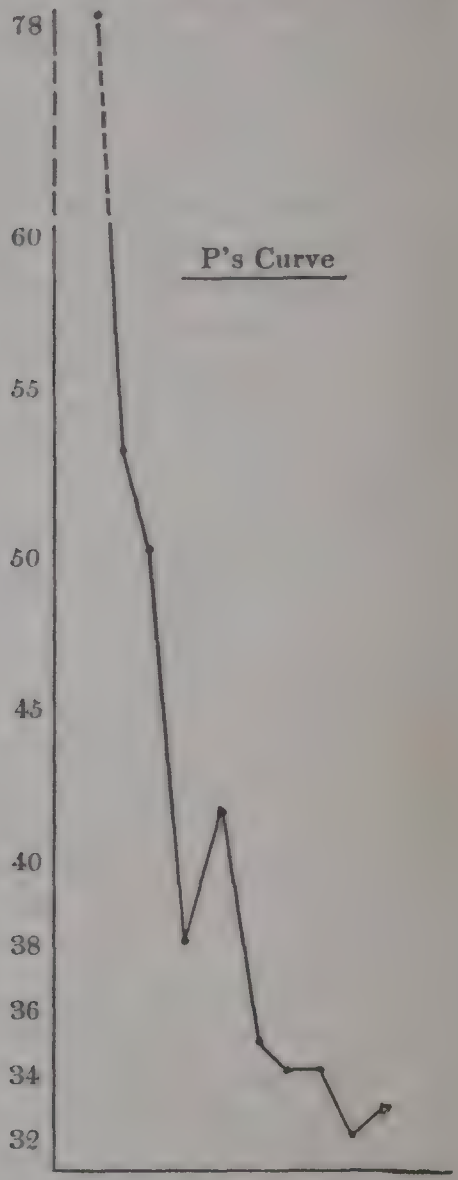


FIGURE 19. THE RECORD CURVE OF *P*

variable factor; whereas in the latter, the material is the constant and the time the variable.

What is the practical value of the learning curve? The learning curve, once it has been constructed, serves two important purposes. In the first place it indicates plainly the uniformity or disuniformity of the establishing of the bonds as they are linked up in the specific process being investigated. Take *J's* learning curve for the digit-symbol substitution test, for instance. (Fig. 14.) In the main there is fairly steady and constant progression. In the fifth practice period a total of 27 symbols is attained; in the tenth the number has risen to 36; in the fifteenth, to 38; in the twentieth to 42; and in the twenty-fifth to 46. But the rise has not by any means been steady and uniform. In the sixth and seventh trials, for example, the number achieved dropped from 27 to 26; in the eleventh, there occurred another drop from 36 to 32; and in the twelfth, to 31; and not until the fourteenth does *J* get back up to 36. There are other drops in the nineteenth and twenty-fourth trials.

In addition to these actual drops, the uniformity of *J's* curve is further broken by the irregularity of its rise. Thus, in the second trial *J* gained but one point over the first, while in the third he gained eight points over the second, and in the tenth five points over the ninth. All these fluctuations and disuniformities are brought out very conspicuously in the learning curves. So far as the physiology of the neuro-muscular system is concerned as a factor in learning, there seems to be no reason why the increment of gain of *x* practice period should be as different from that of *y* practice period as is often found to be the case. There must obviously be some factors — either external or psychological, or both — operating in *J's* learning process which will account for the marked departures from uniformity observable in his rate of acquisition. We shall inquire into the possible nature of such factors shortly. One important service which the learning curve renders is the revealing of disuniformities as well as uniformities of acquisition.

The other practical service rendered by the learning curves lies in the fact that they afford an excellent means of

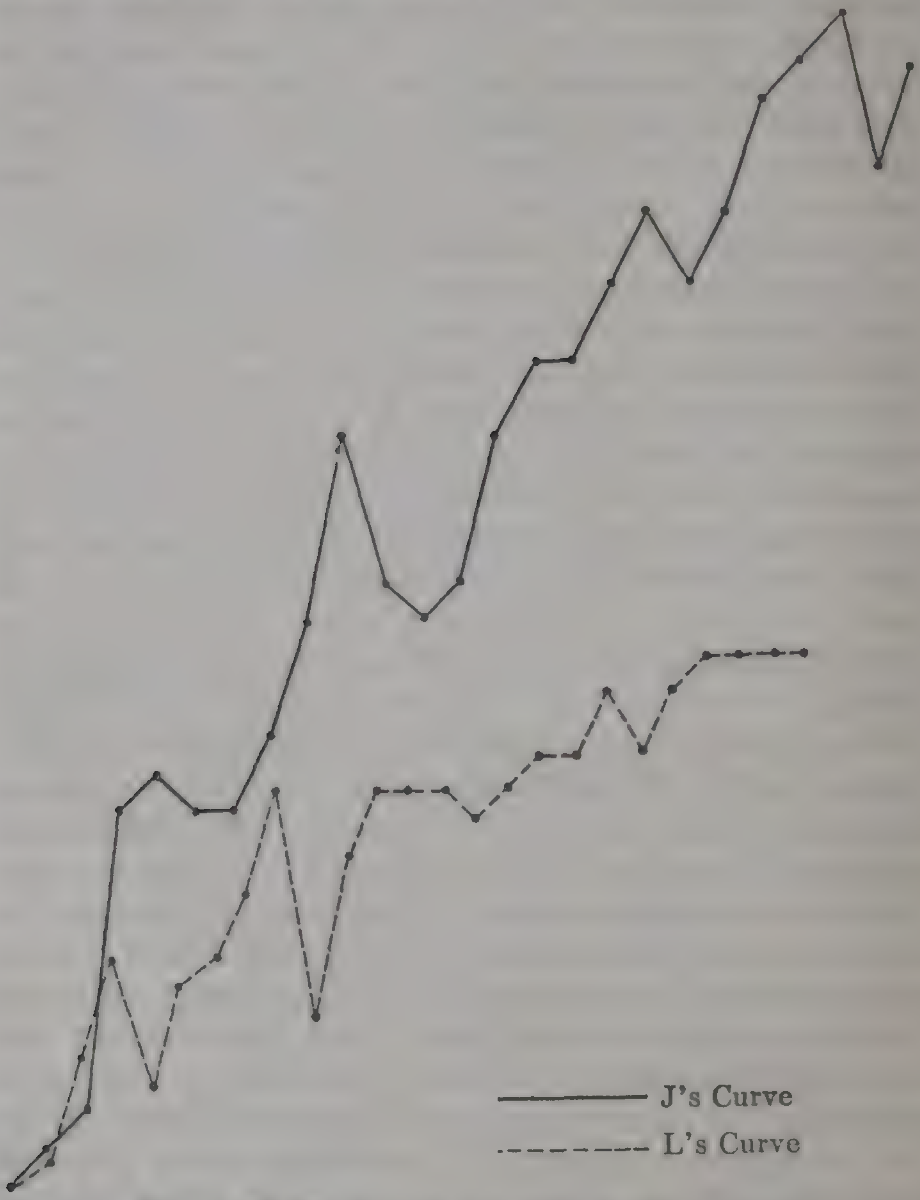


FIGURE 20. TWO ACQUISITION CURVES COMPARED

Indicating a common method of plotting the curves of two or more individuals on the same sheet, a continuous line being drawn to represent one individual, a broken line the other. Colored lines may also be used in case it is desirable to construct the curves of several learners side by side for comparative purposes.

comparison of the progress made by several individuals in the same process of acquisition. Compare, for example, *L's* curve of acquisition for the digit-symbol substitution (Fig. 15) with that of *J* (Fig. 14). Here again the general tendency of progression is upward. In the fifth trial *L* wrote 19 symbols; in the tenth, 21; in the fifteenth, 27; in the twentieth, 29; and in the twenty-fifth, 32. The gross gain from the twenty-five practice periods is much less, however, in the case of *L* than the case of *J*, as Fig. 20 will illustrate.

The rise of *M's* curve is seen to have been also somewhat less uniform than was that of *J's*. In four cases the former's curve actually dropped, while in several cases it remained parallel with the abscissa. Moreover, just as in the case of *J's* curve, the unit increments vary in *M's* curve so that the regularity of its rise is repeatedly broken. Thus, in the second trial, *M* gained one point over the first; in the third, three points over the second, etc., and in the eleventh, four points over the tenth. The plainness with which the learning curves show similarities and dissimilarities in individual performances makes their construction highly desirable.

The plateau. In both *J's* and *M's* curve of learning there is in evidence, as we saw, a general upward tendency, indicating that both learners were making continuous progress in digit-symbol substitution. Both these cases, however, present a picture of the first twenty-five practice minutes only. What will be the complexion of a curve drawn to show the results of the fiftieth to the seventy-fifth practice, or of the seventy-fifth to the one hundredth? Will there still be general progression upwards? If not will the curve tend downward, or will it tend to parallel the abscissa? We may conclude at once that the total increase in efficiency — if increase there be — for the second, or third, or fourth block of twenty-five trials will be appreciably less than for the first twenty-five, inasmuch as the physiological limit would be reached and passed long before the one hundredth trial, if the same rate of acquisition obtained throughout as obtained for the first twenty-five.

Subject *J*, for instance, whose total increase in the first block of twenty-five trials was 30 (i.e., from 16 in the first to 46 in the twenty-fifth), was asked to write just as many ordinary digits in numerical order as she possibly could in one minute, commencing with 1. Inasmuch as she might be assumed to be perfectly able, by virtue of years of experience, to write numbers in sequence without associative effort, it follows that the only limiting factor in this process must have been a physiological one. She was able to write consecutively from 1 to 64 in one minute. Assuming that the digit-symbols are mechanically no harder to make than the ordinary numerals, we must conclude that approximately 64 (⊓ ⊔) represents the physiological limit of *J's* ability to write the digit-symbol notation after the process has become through habituation as automatized as has the writing of the conventional figures. This would mean that, since *J* improved thirty points in the first block of twenty-five trials she would, if she gained at an equal rate subsequently, reach her physiological limit somewhere slightly beyond the middle of the second block — perhaps at about the thirty-ninth or fortieth trials — and that beyond that point there could be no appreciable gain in skill.

Let us now see whether this expectation is borne out in actual practice.

Fig. 21 represents the learning curve of Subject *A* in the first one hundred practice minutes, the same experiment being employed as that used by subjects *J* and *L*.

A's initial score was 22, and his final was 59. In the first block of twenty-five trials his gross gain was twenty-four points (i.e., 46–22); in the second block of twenty-five he gained but eight points over his record for the first series (i.e., 54–46); in the third block he gained only two points over his record for the second series (i.e., 56–54); while in the fourth block he gained three points over his record for the third series (i.e., 59–56).

In one minute (the standard length of practice period allowed) *A* was able to write ordinary numbers from 1 consecutively to 97. The latter number may therefore be

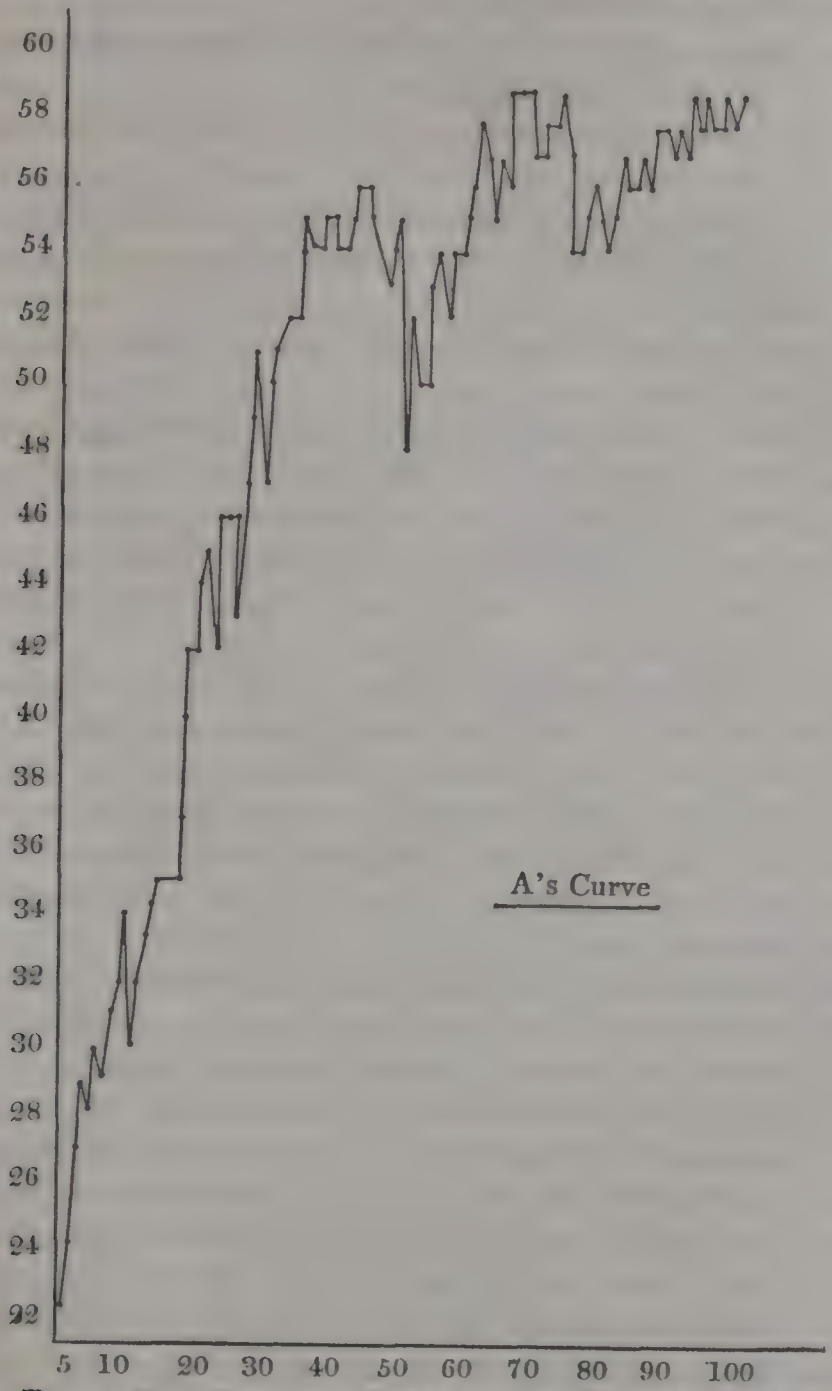


FIGURE 21. A LEARNING CURVE SHOWING PLATEAU LEVELS

assumed to be *A*'s approximate maximum of achievement for the substitution test. But he is obviously approaching that maximum very slowly, gaining only five points in the second fifty practice minutes.

We may, then, draw the following inferences about practice as it affects the learning curve:

(1) The general tendency under practice is for the curve to rise.

(2) Gain in skill is a very slow process, depending upon various factors to be considered in ensuing paragraphs.

(3) Early practice periods give larger returns than later ones.

(4) There comes rather quickly in the learning process a stage where little if any appreciable gain through practice is made over a considerable period. This period of standstill, in which the curve tends to parallel the abscissa, is called *the plateau level in the learning process.*

The significance of the plateau. Observers long since became aware of this plateau phenomenon in various processes of learning. The first definite attempt to account for it was made by Bryan and Harter, in their study of the acquisition of skill in 'receiving' in the telegraphic code.[1] They had their subjects receive telegraphic messages, first in the form of disconnected letters, next as words not making sense, and then of connected discourse, and found that while, after several weeks of practice, the connected discourse curve showed a very rapid rise, the word and letter curves rose much more slowly. The two first (letter habits and word habits) they termed 'lower-order' habits, and the last (connected discourse habits) they termed 'higher-order' habits, and suggested that the cause for the plateaus in the latter was the fixing of these lower-order habits, which must be accomplished before progress to the higher-order habits could come about. Until their subjects possessed the requisite skill to receive disconnected letters and words, they could not "turn their attention to attack the higher-order habits." The plateau, they concluded, "is the measure of the difficulty of making the lower-order habits sufficiently automatic" for use as elements in the higher-order habits.

---

[1] Bryan, W. L., and Harter, N. "Studies in the Telegraphic Language, etc.," in *The Psychological Review*, vol. 6, 1899.

That plateaus commonly exist in learning curves is a foregone conclusion. Subsequent investigators, however, have not been content with Bryan and Harter's original explanation of them. Swift [1] and Leuba,[2] the former from a study of learning an unfamiliar language, the latter from a similar study of learning to write German script, conclude that there is no such time sequence in the development of habits of different orders, but that rather all habits are in process of formation almost from the very beginning, some being succeeded before they have been fully perfected by the next ones already in operation.

Book's study of acquisition skill. Book's classic study of the acquisition of skill in typewriting [3] is the best attempt that has thus far been made to account for the plateau or the 'critical stage' in the learning process. He confirmed Swift's and Leuba's conclusions that there is no time order in the development of the specific habits involved in the mastery of typewriting, and that they developed simultaneously, perfecting each other. What, then, asks Book, can be the factor responsible for the plateau levels if it is not the slow and persisting fixing of elementary habits? The cause, so he concludes, is rather a psychological than a physiological one. At certain levels of advancement there occur lapses in attention, and relaxation of interest and effort. These lapses in spontaneous attention and effort tend regularly to be followed by a rash misapplication of voluntary effort as soon as noticed by the learners. Plateaus are therefore either (*a*) resting-places in the learner's interest and effort; or (*b*) "breakdown stages caused by excessive effort wrongly applied.")

---

[1] Swift, E. J. *Garman Vol. of Studies in Philos. and Psychol.* Boston, 1906.

[2] Leuba, J. H., and Hyde, W. "An Experiment in Learning to Make Hand Movements"; in *Psych. Rev.*, vol. 12, 1905.

[3] Book, W. F. *The Psychology of Skill.* Univ. of Montana Publications in Psychology, Bulletin no. 53, 1908.

Plateau levels are not, as the earliest studies concluded, necessary accompaniments of the learning process. As Book suggests:

> The learner is simply caught by the law of habit and fails to improve because new adaptations or 'short cuts' in method cannot be made unless attention is kept vigorously and properly applied to the work. . . . In all complex forms of learning, where many specific habits are to be formed and where simple elemental habits are continually reorganized into higher-order habits, plateaus naturally tend to occur and often do occur at those stages of advancement where certain elementary habits or groups of such habits are being finally perfected; because at these stages in the learning attention tends strongly and naturally to drift away. . . . This means arrest of progress and the development of all sorts of interfering habits and tendencies.

The studies of Book and other investigators serve to emphasize the importance of an enduring interest in and a high degree of attention to the particular acquisition under practice. The moment the learner's interest wanes, his attention flags and forthwith there ensues a lessened amount of effort and so a slowing up in the rate of acquisition. Applying this fact to the schoolroom we have a full and sufficient explanation of why drill periods need to be brief and breezy; why genuine motivation becomes of preëminent importance in all school work, and why not infrequently children are but little more skillful in handling the fundamental processes of arithmetic, or in writing, or in spelling, or in good reading, or in various other subjects of the curriculum at the completion of one grade than at the end of the preceding. During the lapse of an entire school year they have been see-sawing on the plateau levels, without the requisite interest and determination to guide and inspire them on to the higher stages of progressive skill.

The general nature of learning curves. But even though there be interest and a high degree of attention to assist and spur on the learner so that plateau levels are absent, his rate of progress is by no means uniform and steady. In general, the early trials yield greater returns than an equal number of later trials. As reflected in the learning curve this phenomenon is shown by a rapid and fairly continuous rise in the earlier stages, followed by a much slower rise subsequently until the physiological limit is reached. It is ordinarily also the case that in all types of learning that continue over a long period there occur short periods of non-improvement, or of actual deterioration, to which Book gives the name, 'breathing places.' These may last for several days, but are not so long continued as are the plateaus which regularly occur or tend to occur at definite levels of advancement at the "critical stages" in the learning.

The reason for the marked increase in efficiency in the first stage of a practice period is doubtless due to a spurt of enthusiasm with which the learner sets about his practice. This, of course, is not ordinarily maintained beyond the first few trials, and tends to be succeeded by a slight relaxation of attention or effort, which is reflected in the marked horizontalization tendency of the curve. In general, we may conclude, the typical learning curve rises rapidly at first, then more slowly, occasionally remaining horizontal for a few days during the breathing spaces and, at certain fairly definite and constant stages, over a much longer period (plateau or critical stage), finally reaching its highest level as the physiological limit is approached.

What is true of the completed learning curve is true to a considerable degree also of the daily practice curve. There is likely to be a fairly abrupt rise in the first minutes as the learner 'tunes up' to his task. This is succeeded by a less rapid rise, in which there are occasional slight falls, with often a final spurt as the subject becomes fleetingly aware of the impending signal and throws in consequence greater effort into his practice in order to finish in good form.

Book comments thus upon the daily curves of his typewriting subjects:

> It has long been known that the amount of work that an individual would accomplish, if called upon to do continuous mental or physical work, varied in characteristic ways depending upon the individual workers and the period of work. . . . Our curves show that there is a marked high start (higher than the rate for the second minute) and a final rise in efficiency for the last minute of the tests. The curves for the touch method writing do not show the initial rise in efficiency. There is a gradual rise up to the fifth minute of the tests followed by a decided drop the next two minutes and a final rise the last three minutes of the tests. The increase in efficiency for the first five minutes would seem to be due to the relearning and warming up already described. There was no drop in effort after the first minute of these shorter touch method tests because there was no thought of a long period of practice ahead to reduce the enthusiasm with which the learners started. They started in at their best rate which they kept up until overcome by fatigue towards the middle of their tests. This caused a relaxation of attention and effort, but as they neared the end of their tests, which they could judge pretty accurately, they again urged themselves on to greater endeavor, the final spurt in effort accounting for the increased efficiency for the last one or two minutes of the tests. In the sight method learning, on the other hand, where the tests were thirty minutes long, the high degree of effort with which the learners started could not be kept up. Their spurt of enthusiasm was conquered by the unconscious thought of the long period of work ahead. Not to take it more easily would have meant to break down before the end of the test. We may, therefore, conclude that the drop in their curves for the second minute was caused by a relaxation of attention or effort, while the slight rise after this was due to relearning and warming up, extra effort being again put into the writing as the end of the first third of the test was approached, where time was called.

Another interesting fact concerning the daily practice curve is that often it starts off at a point somewhat below

Habit be the fly wheel
of Society

the point of maximum achievement of the preceding day's test. It very quickly rises to that level, however, and reaches — except, as we have seen, in the critical stages or toward the achievement of the physiological limit — a new daily level above that attained on the preceding day. Thus, in the digit-symbol substitution curve of Subject *A*, the first four days of practice gave the following results:

TABLE I

DAY	POINT OF MAXIMUM ACHIEVEMENT	STARTING-POINT ON FOLLOWING DAY	TRIAL AT WHICH POINT OF MAXIMUM ACHIEVEMENT OF PREVIOUS DAY WAS REACHED
1st. .	47	43	5th
2d. . .	56	48	11th
3d. . .	59		

The reason for the initial lower scores in succeeding days of practice is to be found in the fact that some little of the skill acquired on a particular day is forgotten. The associations do not work as spontaneously and promptly at first as they do after they have begun to flow. A sheer act of will is not sufficient stimulus to call old habits into functioning: they must be carefully and more or less consciously reëxercised, in order that the subconscious chain of reflexes may be reëstablished.

QUESTIONS AND PROBLEMS

1. What is meant by a 'smoothed curve'? How is a curve 'smoothed,' and why is it sometimes done?
2. Prepare a good statement on the general subject of "Plateaus in the learning curve."
3. In the light of the discussion in this Lesson, look over your notes on

the substitution and card-sorting experiments and try to account for the complexion of the curves.

4. Read and report on some current article in the literature in which learning curves are introduced.
5. Make a synopsis of Book's monograph on *The Psychology of Skill.*
6. What practical use can a teacher of, say, the fourth grade, make of the learning curve? Illustrate. Be on the watch in the training school for uses which the teachers make of the curve.

SELECTED REFERENCES

1. Pyle, W. H. *The Psychology of Learning,* chapter 2.
2. Strong, E. K. *Introductory Psychology for Teachers,* pp. 24 and 46. Also Lessons 24, 29, and 30.

LESSON 8

SENSORI-MOTOR AND PERCEPTUAL LEARNING

EXPERIMENTS:

11. *Discrimination of brightness.* Secure a piece of light gray paper and cut from it five strips about $\frac{1}{2} \times 1\frac{1}{2}$ inches. Cut five pieces of cardboard, about 4 × 6 inches, and paste a strip of the gray paper in the left center of each. Collect four other strips of gray, each a trifle darker than the other, and the lightest of them a trifle darker than the strips already pasted on the cardboard. Paste one of them on each of four of the five cardboards in the right center, symmetrical with those in the left center. In the right center of the fifth card paste another strip of gray, exactly the same as that in the left center. Mark the cards in such a way on the back that *E* can always be sure which side of the card the darker shade is on. For the experiment, let *E* expose the cards in indiscriminate order for five seconds, asking *S* always the stereotyped question: "Which is the darker?" *S* should answer always "Right," "Left," or "Same." *E* should narrow *S* down to the lowest difference possible for him to perceive and then, using that card, proceed to test him out by exposing the card ten additional times, turning it about so that the right shade is the darker five times and the left the darker five times. If *S* gets eight out of ten correct, that card may be deemed to represent his limen of discriminative color perception. If *S* gets less than eight out of the ten correct, try the card representing the next higher difference, and proceed in the same way. Confirm results by using the next higher and the next lower cards.

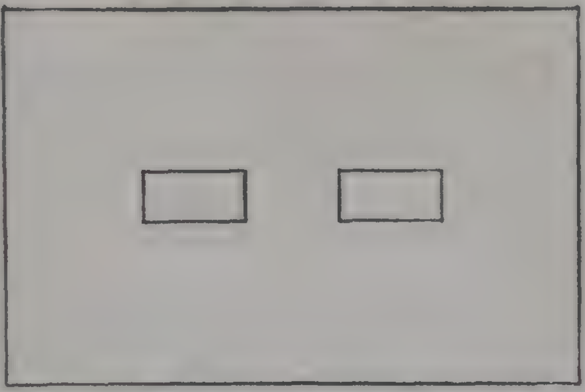


FIGURE 22. COLOR DISCRIMINATION CARDS

If possible, use the specially standardized cards of Whipple, Test 17. For other tests in perceptual discrimination, see Whipple, Tests 19, 20, 21, and 23. Test 20 is especially valuable.

12. *Discrimination of weight.* Perform the Binet weight-arranging test (Yr. IX, Test 2, Terman) on several third- or fourth-grade children.

13. *Perceptual learning.* On a card about 4 × 6 inches sketch any simple figure similar to that in Fig. 23. Be sure it involves no marked technical difficulty, and yet is sufficiently detailed to test accuracy of observation. Expose the card ten seconds, after which *S* should immediately try to reproduce it from memory. Repeat the exposures, instructing *S* to fold his paper over each time, until his results are tolerably accurate. Prepare other drawings in the same way and expose them similarly. *S* is to write up his introspective analysis, bearing particularly in mind any associations suggested by the diagrams, the activity or passivity of his inspection, and evidences of analysis and synthesis. He should also keep a record of the trials and number of errors after each exposure. These data may be arranged in comparative tables illustrating the results obtained by each *S*.

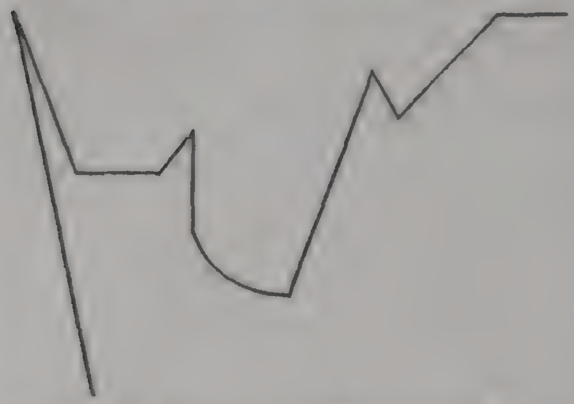


FIGURE 23. CURVE FOR PERCEPTION TEST

14. *Tachistoscopy.* Construct a simple exposure-apparatus, or tachistoscope, by arranging a sliding board, with a ten-inch square hole cut in its center, between two uprights. Fix a support for the exposure cards in such a way that when the slide is raised the card will be invisible, and when it is dropped the card will be revealed for an instant. Prepare several cards of twelve-inch white cardboard, with two-inch margins, and paste on them in unsymmetrical order letters, digits, words, nonsense syllables, hues, etc., in groups of three, four, five, six, seven, and eight. After the slide is raised, insert a card and instruct *S* to watch carefully. Drop the slide. *S* should at once note down what he saw in the fleeting exposure. Find the range of perception of each *S* for various stimulus cards. The introspective analysis should be carefully written up in the notebook.

15. *Cancellation test.* Prepare on the typewriter identical ten-line sheets of pied material, by striking indiscriminately the keys of the entire keyboard, without spacing or punctuation of any sort, until the ten lines are filled. At the signal, *S* is instructed to cancel every *t*, for example, in the pi, working as rapidly and accurately as possible. Any letter may be designated by *E* for cancellation, but he should be careful in preparing the sheet that, in a sixty-letter line, the designated letter appears from five to eight times. The experiment may show that some letters may be much more readily perceived than others. *E* should keep a careful record of the time consumed by each *S* between the signal and the finish. The *S's* should write up their introspection in the notebooks.

Recapitulation. It will be recalled that, in Lesson 5 (*q.v.*), we classified the learning process according to four principles: (1) according to the goal to be achieved by the learner; (2) according to the rank of the learner; (3) according to the type of learning involved; and (4) according to the method employed by the learner. Thus far we have discussed the first two of these only, turning aside briefly in Lesson 7 to consider the Learning Curve. We now resume the discussion of these principles of classification, the third of which was the type of learning involved. Under this caption we may distinguish three types of learning; namely: (1) sensori-motor learning; (2) perceptual learning; and (3) associative learning. In this lesson we shall limit ourselves to the first two.

[illegible] # [illegible]

1. Sensori-motor learning

Nature of sensori-motor learning. The first type of learning is frequently referred to as *sensori-motor* learning. It might equally well be designated 'muscular' learning, or 'physical' learning, the essence of it being modifications wrought in the neuro-muscular mechanism through training or practice. In our discussion in Lesson 5 of the two goals of all learning, namely, skill and knowledge, we took occasion to remark that this control over muscular movement (p. 83) results in skill. That was merely another way of saying that all types of learning which have skill as their goal involve a maximum of sensori-motor learning. We used the illustrations among others of the skills acquired by the watch repairman and by the bicyclist, in both of whom the deftness and cleverness of movement are but the evidence of controlled motor coördinations. Let us endeavor to account for the fitness of the term sensori-motor as applying to all learning in which such motor coördinations are involved.

In this type of learning, the stimulus acts as a goad to reaction; in this respect, as we shall see shortly, sensori-motor learning differs sharply from perceptual learning, the latter type being accomplished with the *comprehension* of the stimulus: no further response is necessary, though it is often a consequence to be sure. In the former type, however, the end is not understanding of the stimulus, but rather motor reaction to it. This motor reaction is, as we have already seen, a series of motor reflexes built up through repeated practice, and dependent as to their number and complexity upon the simplicity or the intricacy of the reaction. In driving a nail, for example — which is a good illustration of sensori-motor skill — the series of reflexes is relatively simple. Awareness that the hammer has struck sets off the appropriate motor responses of raising, poising, and re-directing it downward toward and against the nail. In such a process as that represented by the fingering of the keyboard of the piano — in the rendition of a *fugue* of Bach, for example — the series of reflexes is much more intricately involved. The *skills* required by both are nevertheless sensori-motor. Sensori-motor learning, or the process of the attainment of skill, comprises essentially the perfecting of certain simple or involved motor adjustments, initiated and directed for the most part by peripheral neural stimuli, i.e., sense impressions.

Experiments with ball-tossing. Professor Swift's experiments with the tossing and catching of balls is one of the best-known efforts to analyze the sensori-motor type of learning. Six young men served as the learners, their task being to achieve skill in keeping two balls going with one hand, catching and throwing one of them while the other was in the air. Ten series constituted the daily practice, a series being the period during which the subject was successful in keeping both balls from dropping to the floor. The practice was continued in the case of four of the six subjects until the average number of catches for each of the ten series was in excess of one hundred for two days in succession. The nature of the task was obviously the development in the learners of dependable motor coördinations of finger, arm, and back muscles. What now were some of the interesting and significant results incident to the acquirement of skill in this sort of performance?

One of the most common 'errors' in the earlier days of the experiment was 'wild throwing'; i.e., tossing the ball in such a way that it fell out of easy reach. Another error was observed to be 'clumsy catching'; i.e., not being able to hold the ball when it actually touched the hand in falling. Both these errors of performance represent merely lack of skill, with its consequent excess of voluntary concentration and 'wild' movements. Clever and automatic coördinations could come only with added practice series. None of the subjects having meditated upon what method they would probably find best, each individual developed his own peculiarities of technique. This was noted particularly in the manner in which they sought to avoid collisions. One learner soon found himself avoiding collisions by "tossing the balls up a little to his right and in such a way that they would take a circular course, coming down in front of him."

"Two found themselves tossing the balls up at arm's length in front so that they took a circular course toward the subject, coming down closer to his body." Two others maintained the balls in parallel columns a little to the right of the median line of the body. "With this method the balls fell periodically into a 'mix-up,' and then the subjects were compelled to toss high until they straightened out the tangle, when they would settle down again into the same parallel columns." All the curves constructed by Professor Swift showed great irregularity of progress. In general, as might be expected from such a type of learning, progress was at first very slow, and then, as skill developed, it became more and more rapid. Plateaus were numerous.

In the matter of interest, Professor Swift[1] says:

> In ball-tossing, after one has reached a fair degree of proficiency, the first part of each series is always something of a bore till the fifty mark is passed, when it becomes interesting. Later, the interest may take another slump, rising again after the score has reached one hundred. At this point the possibility of an unusually high score keeps the subject alert to the end. There was also a plateau in the interest of some of the men, after throwing, for the first time, a hundred in a single trial, for which they had been very keen. They felt that it was impossible to reach the two hundred mark at once, and the total thousand was too far off to be alluring, so the edge of their enthusiasm was turned. Later, when the chance to make another record seemed good, they became as alert as ever. Indeed, after the satisfaction of having thrown a hundred had subsided, and the work continued for a time without great progress, the first twenty-five took on an acquired interest in the anxiety to finish the work. This brought greater care.

What practical conclusions concerning the nature of sensori-motor learning does the experiment with ball-tossing justify? (1) In the first place, we may conclude that conspicuous absence of skill, as represented by random and rash movements, precedes the attainment of skill. You have but to observe the initial stages of progress in any sort of physical performance to find this principle verified (2) Second, an excess of concentration attends the early stages of the achievement of dexterity. This bringing of attention to bear upon coördinated movements not only complicates matters but also fatigues the learner. Pay voluntary attention to some habituated process, such as locomotion, and you become at once awkward. It is a fact, however, that a preliminary stage of profound attentiveness must precede the attainment of higher stages of skill (3) Third, in the acquiring of skill, the successful, i.e., the economical movements, are rarely envisaged beforehand, but are 'hit upon' by trial and error. Once they have been sifted out from the mass of random movements, however, they are appropriated consciously, and subsequent improvement is thus made possible. Finally, in the fourth place, there is no royal road to skill. Its foundations lie amid trial-and-error ruins, and its walls are reared into view but slowly. A grand old teacher whom the writer once had was wont to say, in his laboratory: "There are three laws of learning; the first is repetition; the second is repetition; and the third is repetition." Surely learning of the neuro-muscular sort offers no exception.

---

[1] Swift, E. J. *Mind in the Making*, pp. 170 ff.

Some schoolroom illustrations of sensori-motor learning. We are now in a position to ask ourselves, What are some of the ordinary activities skill in which is asked of the schoolroom pupil? What is the part played by sensori-motor learning in the so-called educative process? In general we may say, in answer to these questions, that any schoolroom activity in which skill of hand, arm, vocal cord, or other muscle group is aimed after belongs within the meaning of the expression: sensori-motor learning. Specifically, we may take learning to write as the type of sensori-motor activity involving skill of hand. The process of mastering the art of writing involves the highly specialized training of each finger. One is not conscious of the considerable part played by any one of the fingers in this process until an accident has deprived him of one of them; thereafter he must all but learn to write over again. The thumb, forefinger, and middle finger are trained to hold the pencil, while the two other fingers are trained to guide and balance. In the wrist movement, delicate adjustments must be built up in such a way as to coördinate with movements of fingers and arm. All these niceties of control and coördination and direction are constructed slowly, not so much in spite of but rather as a natural result of a multiplicity of useless and rambling movements, not only of the muscle groups ultimately to be involved in writing, but of many which will finally be found unnecessary. Thus, as we have seen, does a stage of conspicuous absence of skill precede its final attainment. All this superfluity of motor discharge is of course attended by a maximum of attention, misapplied though it is. What wonder that both speed and form in handwriting are acquired but slowly and even painfully!

In the drawing of rectilinear or curved figures, or of any other type of figure or object, skill is achieved by the pupil in precisely the same way. Learning to read, i.e., to pronounce rapidly and to articulate roundly; to play the piano, i.e., to manipulate the keys; to sing in tune, i.e., to control the vocal cords — these are other illustrations of school activities of the sensori-motor sort. In manual training, handling the plane and saw and hammer; in the gymnasium, tumbling, 'standing on the head,' vaulting, wrestling, boxing, fencing; on the playground, running, pitching, kicking, batting, throwing — these are other illustrations in kind. In all of them the goal sought is physical or muscular skill.

Conditions of dexterity in sensori-motor learning. The one essential and indispensable condition of the achievement of skill in any art is practice. Other things being equal, the difference between the clever worker in any art or craft and the bungler is the difference in practice along the lines represented in the activity. Before me, for illustration, is an announcement of a Civil Service examination for stenographers, to be held shortly. Under the section dealing with qualifications of applicants is a weighted table, which shows fifty per cent of the credits to be computed on the basis of training and experience. Presumably of two candidates of approximately similar qualifications in all other points, the one who had been trained in stenography and who had actually been employed successfully in it would stand a much greater chance of securing an appointment in the Service. So with workers in any other line which requires a degree of clever craftsmanship. A mechanic or plumber, or a carpenter or mason, will be dependent for permanence of employment and for scale of remuneration upon the item of actual training or accumulating experience. A picturesque example of practice as a condition of dependability and trust is seen in the railroad regulations which require an engineer to have worked for a long period on switch engines, shunting cars to and fro in the yard, before he is permitted to take a train out on the line, and even then it must be only a freight train. If he stands the test, and proves to have the qualifications of the trustworthy engineer, he is finally rewarded by being granted the proud distinction of hauling precious human passengers behind him. And much of his trustworthiness is due to certain highly specialized skills of hand and muscle.

Secondary conditions of skill: interest. The prime condition of skill is, then, practice, and it is this that makes the child of ten a better talker, player, batter, draftsman, runner, walker, vocalizer, pitcher, thrower, than the child of five. But there are two other secondary conditions of skill in sensori-motor performance. The first of these is interest. Professor Swift found in his ball-tossing experiment, it will be recalled, that interest in the score paralleled the achievement of the several learners. Alertness and carefulness were lacking when interest waned. The tossers became merely automatons, without zest or ambition. But when the possibilities of making a record seemed good their enthusiasm returned, accompanied by alertness and caution in the performance.

Ball-tossing is analogous in this respect to any other type of physical activity in which sensori-motor skill is concerned. The uninterested workman, lacking as he does zest, determination, and even eagerness, is a low-level workman, little better than a machine. It is unfortunate that one of the results of the mechanization of modern industry is the increasing tendency for the worker to be merely the operative of a machine, being required to do only a half-dozen movements over and over throughout the entire working day. It is not to be marveled at that the modern industrial worker is often uninterested in a manufacturing process in which he plays spiritually and intellectually so minor a part. It was not always thus. Time was when the worker was a skilled craftsman, a master in his line, or else an apprentice who was looking eagerly forward to that happy condition of cleverness. It is this change in the spiritual status of the worker that represents one of the prime underlying causes of modern industrial unrest.

What we have said of the workman in industry is true also of the child-workman in the schoolroom — the uninterested pupil is the low-level pupil. Obsolete methods, lack of motivation, confused ideas in the mind of the pupil as to what it is all about — all conspire to stifle any keen interest in the educative process. The result is low-pressure work, dawdling, listlessness, and often even rebellion. We must not forget in this connection, of course, that haphazard grading of children is another factor which makes for misfits in the grades and adds to the complexity of the problem. In any case, whatever be the cause and the remedy, high peaks of educational achievement are not for the half-hearted and the lackadaisical: they are to be scaled only by those who are borne forward by an irrepressible enthusiasm and interest in actual conquest. This is as much true of the process of skill-acquiring as it is of knowledge-getting.

A recent book,[1] commenting on the unfortunate consequences of a lack of strong interest in his school work on the part of the learner, says:

> The fundamental difficulty is that the work in which the school seeks to engage the child is not significant to him. It does not satisfy the needs which the individual child experiences. It does not gratify any hunger or yearning he has felt. It does not answer

---

[1] Wilson, H. B. and G. M. *The Motivation of School Work*, p. 10.

any questions which his experiences have raised in his mind. It does not contribute to the solution of any problems which he has encountered in actual life. With the work thus external and foreign to the child's personal hungers, longings, questions, experiences, and problems, it does not render him aggressively self-active. In the average school, we find him listlessly sitting, looking, listening, and answering when questioned, rather than initiating, doing, and creating. Yet we know definitely that growth and mastery can come to the child only as a result of vigorous, aggressive self-activity.

Another secondary condition: encouragement. But there is still another secondary condition of skill which has to do not with the opportunities for or amount of practice in any activity, nor yet the inherent interest which the learner may possess in it; it has rather to do with the extraneous factor of encouragement. This is a most valuable supplementary condition of the acquisition of skill, particularly during the early stages of practice. It is not of course an indispensable factor in achievement, but its presence certainly lightens if it does not hasten the process. In this connection it is doubtful whether any quality of a professional sort is of greater importance to the teacher than sympathetic interest in the advancement of skill or the development of power in those committed to her direction. As Dr. Burnham has well said,[1] the results of continuous and repeated failure on the part of the school child are no less than disastrous, and the teacher should deem it a responsibility of no little consequence so to manipulate the educative process that every child, however little gifted or able, may feel frequently the stimulus that comes of success in this subject or in that. This bit of schoolroom philosophy will brighten the educational pathway for the meagerly endowed, as surely as it will that for the highly endowed.

In fine, to be aware of growing skill through wise conditions of practice, to be conscious of a deepening interest as power and control in performance increase, and to be inspired by judiciously sympathetic teachers — these are the three circumstances which apply to all learning, and which cannot but lead the way to high achievement.

---

[1] Burnham, W. H. "Success and Failure as Conditions of Mental Health"; in *Mental Hygiene*, vol. III, 1919.

2. Perceptual learning

What perceptual learning is. As we have seen, the end of sensori-motor learning is physical skill through neuromuscular control and coördination. The goal of perceptual learning is, on the other hand, a more strictly intellectual one. We may define perceptual learning as that sort of learning which has to do with recognizing, understanding, or interpreting a stimulus. The stimulus must always be present to the senses, and the process is therefore externally rather than internally or centrally aroused. Sensori-motor learning, we found, uses the stimulus merely as the means or starting-point to a definitely motor response. Perception is limited solely to the taking in of the significance of the stimulus through the operation of various associative or central factors which render the individual able actually to comprehend the situation presented to the senses. Winch[1] emphasizes as inherent also within the meaning of the term perception the *expression* of what is perceived in linguistic or graphic form. To the process he applies the name: *declaration of perceptual judgments.* The simpler term *observation*, as he points out, might be as aptly applied to this form of reaction as the term perception, provided we understand by observation sensory discrimination, the identification of what is sensorily apprehended, and the expression of this identification in linguistic or graphic form.

The 'Aussage' method. Psychologists have developed a method of testing the capacity of subjects to observe, or perceive, to which the German school gives the name *Aussage.* The English school uses the same method under the designation of *declaration of perceptual judgments.* In America the method is more often referred to as *fidelity of*

---

[1] Winch, W. H. *Children's Perceptions*, p. 3.

report. In essence the Aussage method is a means of studying the accuracy and range of sense perception of individual subjects. It consists in a brief exposure of a picture, colored or otherwise, which is possessed of some simple detail. After the exposure of the stimulus a report, either verbal or written, with or without stimulus questions, is called for immediately, and the subject at once tells (*sagt aus*, from *aussagen*, to *say out;* hence the name of the method: *Aussage*) what objects he has perceived in the picture. The length of exposure varies somewhat with the simplicity or complexity of the picture used, and with the maturity of the subject being tested. Younger subjects are allowed a longer time than older ones for a given picture.

Fig. 24 represents the picture used by Winch in testing the perceptual abilities of London school children. An exposure of exactly one minute was made, after which the child was invited to say what he had seen in the picture. Following this spontaneous report, questions like the following were asked and the answers recorded:

1. Which side of the table was the lady standing?
2. What was she doing?
3. How was the lady holding what she had in her hand?
4. Had the lady anything else in her hand beside the thing you have told me about?
5. What clothes was the lady wearing?
6. What sort of a hat had she?
7. What was she wearing on her feet?
8. Could you see her feet?
9. Had she a pinafore or apron on?
10. Had she a frock on?

Altogether there were fifty questions to be answered, similar in nature to the first ten, given above. Some of them were 'catch' questions, as for example: "What could you see through the open window?" "What color was the carpet?" etc. Such questions as these test the child's resistance power to suggestion, which Winch found to be very weak indeed in the case of children in the infant schools (i.e., the kindergartens). Older children were appreciably less suggestible, becoming by the age of seven surprisingly unsuggestible. Winch believes this factor of impermeability to suggestion to be a rather good criterion of general mental development. Eight of the fifty interrogatories contained suggestion.

In the matter of observation of simple activities, typified by the question, "What was the lady doing?" Winch concludes that it is extremely doubtful whether there is any improvement during school life at all. He reached the same conclusion concerning spontaneous interest in number. In color perception, typified by the question, "What color was the table?" there was a fairly steady gain for all children up to seven or eight years, the girls thereafter however doing steadily better than the boys. In general, says Winch:

> . . . the capacity to observe and report grows rapidly from the age of three up to the age of six or seven, and then suffers a check. . . . That observational work of a very high character can be obtained from all children is shown by the whole progress of this research. . . . There seems an increasing resistance to suggestion, and an increasing capacity to observe clothing and the position and relation between things. . . . Girls are more proficient than boys both in the linguistic expression of their observations and in the number and accuracy of them. . . .

Winch's attempt to discover certain facts about children's perceptions, as illustrated above, demonstrates the wisdom of the Aussage method actually being employed in the schoolroom. Especially is this the case with kindergarten and lower primary children, and many of our best teachers of these grades are placing considerable emphasis on observation lessons in which perception and accurate observation and expression on the part of the children are called for. We must await more investigation before we know whether such lessons are of value pedagogically for older children. The probabilities are, however, that occasional lessons of this sort may be of much diagnostic value in understanding and grading students of any age.

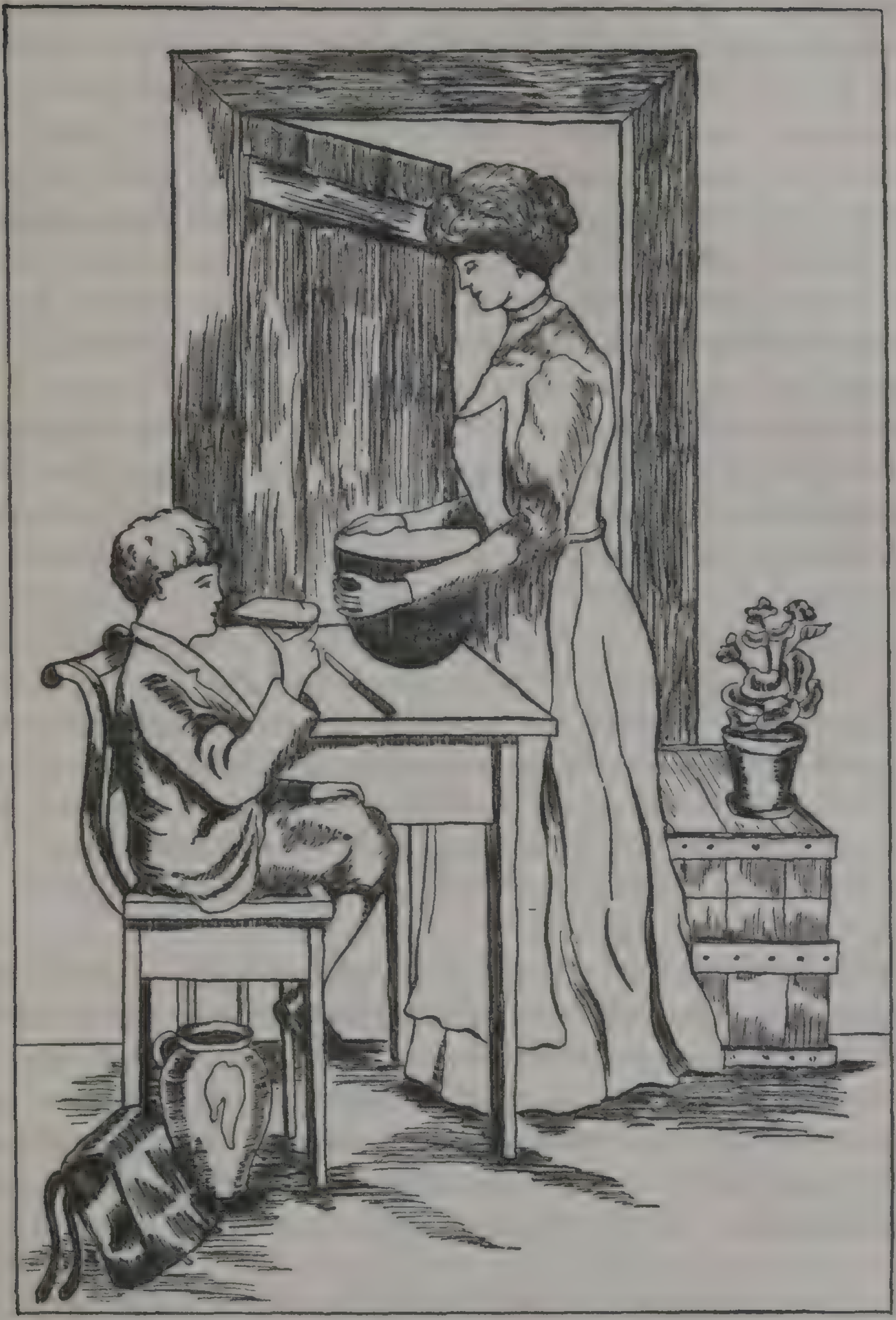


FIGURE 24. WINCH'S PERCEPTUAL TEST

Reproduced, with the omission of colors, from Winch's *Children's Perceptions*, by permission of Messrs. Warwick and York

Analysis and synthesis in the building up of perceptual knowledge. If the reader has followed the preceding discussion carefully, he has already taken note of the fact that two distinct steps are gone through in the building up of perceptual knowledge. The first is what we may call *analysis*, or perhaps better, discrimination between the several sensations or between the several elements in a sensation ensemble. The second is the *synthesizing*, or combining of these various sense elements into a unified percept. Thus, in the picture used by Winch in his investigation of the perceptive process, there are to be seen several objects of different sizes and shapes, two persons, clad in quite different clothing, together with proportions, perspective, and other mechanical factors. Before a subject could report the results of his observation he must first be given an opportunity to identify, to compare, to contrast, to relate, in other words to analyze the several kinds of sense stuff that was offered. Unless he possessed through past experience this interesting capacity to discriminate between elements in a sensory experience, he could make out of the stimulus picture nothing more than a tangled mass of unrelated sensations. Possessing this faculty, however, the subject is able to achieve the second stage, synthesis, of which we shall speak shortly.

We are not to understand, however, that the mind of the observer is compelled laboriously to dissect the objects which impinge upon the sense organs and then, having envisaged the elements, as laboriously recombine them into the perception ensemble. The entire process of analysis and synthesis is at once simultaneous and immediate for consciousness. As Professor Judd puts it:[1]

> . . . The visual and auditory sensation factors (in the case of watching and listening to a speaker) are not first considered as separate phases of experience, and then voluntarily combined with each other by an additional process of thought. The total mass of sensory experience present at the moment is combined by the

---

[1] Judd, C. H. *Psychology*, pp. 134 ff.

listener into a single act of perceptual recognition and interpretation, and this single act is quite as immediate for consciousness as the reception of the sensations themselves. . . . Sensations are never isolated factors in mental life; they are immediately fused with each other.

Individual differences in discrimination. The initial step in the building up of perceptual understanding (sensory discrimination) is found to vary with the age, sex, original nature, and previous experience of the observer — a fact which accounts in considerable measure for the strikingly different versions several witnesses of the same occurrence will give under oath. It will be interesting to refer briefly here to such differences in discriminational accuracy as may be significant for pedagogical principles. In the matter of color discrimination, Winch found London school children in the infant schools and lower forms to show little aptness. Their observation of colors appeared to be governed largely by their emotional interests in them, rather than by any keen intellectual appreciation. Among older children, as we would expect, he found girls to be distinctly superior to boys.

Discrimination not between colors but between degrees of brightness or saturation has been the subject of experimental inquiry by a considerable number of investigators. Spearman found training along this line to be distinctly valuable, those who had been given opportunity to practice averaging approximately four times more efficient in brightness discrimination than those not previously so trained. As in the case of color perception, most investigators have found that women and girls excel males. No experiments so far as the writer is aware, however, have succeeded in demonstrating any very decided correlation between keenness in visual discrimination and general intelligence.

In auditory discrimination much interesting work has been done. Seashore, whose investigations have been extensive in this field, concludes that not only are there wide variations in acuity or dullness of hearing, but that most individuals have a decided difference between the sharpness of hearing in the two ears, that acuity improves on the whole up to the twelfth year, and that there are no noticeable sex differences in this respect. He fails to confirm, however, the findings of some investigators to the effect that a correlation of some significance exists between acuity of hearing and brightness. F. G. Bruner, who tested the hearing of primitive peoples at the St. Louis Exposition, found whites superior in acuteness of hearing to them all.[1] In tests of pitch discrimination in musical tones, the individual differences are quite remarkable, some subjects being tone-deaf, others being capable of discriminating a difference as low as two vibrations. Sex differences are doubtful. There is evidence that improvement takes place fairly steadily up to the age of ten years. Tests in weight discrimination, in which much work has been done, show similar wide individual variations of subjects, and that improvement due to practice is relatively non-existent.

Importance of sense testing. It is a cardinal principle of all education that normally functioning sense organs condition accurate and efficient perceiving. Inasmuch as the initial stage of perception must be the analytic process of discriminating between sense elements, it follows that the swiftness and accuracy of a percept are as the keenness of the perceiving organism. Hence the importance in our schools of a system of health examination that will be one hundred per cent efficient in the detection of any weakness or irregularity of the two master sense-organs — eye and ear. The superficial systems of 'medical inspection,' so-called, are often little more than farcical in the actual diagnosis of sense-organs. Children themselves, possessed it may be of quite inefficient vision or audition, are often totally unaware of their low-grade capacities in these respects, having never seen or heard acutely and hence having no basis of judging. Parents and teachers even are often unaware of deficiencies of this sort in their children, and consequently tend to misjudge those deficient as dull or stupid.

---

[1] The races tested included: Indians, Filipinos, Ainus, and Pigmies.

Is sense-training necessary? Sense testing is, then, indispensable in any efficient school system. But what of definite sense-training? Can an eye, not in itself deficient, be trained through practice to observe more keenly? Or an ear to hear more discriminatingly? These are much-disputed questions, opinion being distinctly divided and practice disuniform. Kindergarten and Montessori schools are likely to place some emphasis on games and plays that are calculated to sharpen the eyes and ears of the little folks. This would seem to be justified by the findings of many investigators with respect to the improvability of discrimination up to eight to ten years of age, although we should not forget Winch's conclusion that color perception and discrimination in very young children are largely a matter of emotional interest. There can be no doubt that the abilities if not the capacities of men are distinctly below those of women to perceive and name colors and shades; this being the case, it would appear that some intensive work with boys ought to repay teachers!

It is probable that any formal attention given by teachers of older children to sense-training is largely wasted, cleverness of discrimination and observation arising more spontaneously and naturally as a by-product of the educational process. In this connection, such incidental training in perception as accompanies the regular curricular work in drawing, music, language, and arts is probably sufficient if properly conditioned. Occasional exercises in keenness of perception of hearing or seeing are, of course, never out of place because of the spontaneity of interest which they engender. But after all, what is needed to make boys and girls good perceivers is not formal drill in sense discrimination and observation; what is needed are more and wider experiences: thus will whatever sense-training is needed be incidentally and naturally received.

We ought perhaps to add that formal sense-training is given quite extensively by teachers to mentally deficient pupils. With such children, work of this sort is not properly limited to the eye and ear; each of the other senses may profitably be drilled, notably the tactile and the kinæsthetic. In the absence of experimental evidence, we are probably justified in assuming that greater returns are yielded from formal sense-training of subnormal children than from an equivalent amount of work along this line with normals.

Fusion of sense elements into percepts. Sensory stimuli and unified perceptions are so intimately related, and so simultaneous in conscious experience, that it is difficult even in our discussion of them to keep them apart. We have already quoted Professor Judd's statement concerning their simultaneity of reception by the observing subject. For most purposes of life and for most occupations this fusing phenomenon is a matter of economy of consciousness. Tea-tasters, piano-tuners, and art critics may find their sort of cleverness dependent upon the analyzing phase of perception. Most of us, however, are not called upon to stress this side of the perceiving process, whatever astuteness of comprehension we have being the product of the second phase of perception: *fusion.*

Fusion comes about as the resultant of an apperceptive consciousness reacting upon the materials supplied by the senses. It is distinctly a mental process of building up, of combining into unity of these materials. It involves the interposition of lightning-like flashes from past accumulated experience which interprets and makes intelligible. There is a stage in the life of every child when it stares uncomprehending at this or that object because it is meaningless, either *in toto* or *in multo.* Experience has garnered no interpretative centers. What will one day be perceived as a rose is to-day to the infant nothing more than an irregular jumble, undifferentiated from surrounding objects. So with its comprehension of the rattle, the chair, the table; none are perceived as such without experiences with them. But by a marvelous patching together of this and that experience, it comes surprisingly soon to get *meanings:* it is becoming a *perceiver*. What with seeing and shaking and listening to the rattle, it is analyzing, and as it further and repeatedly analyzes, traces of yesterday's analyses flash out to fuse all these sensory data into undifferentiated perceptions. Added experiences simply abbreviate the time required for this dual process of synthesis and analysis, until the point is reached with respect to every object encountered where presentation of the stimulus will result to all intents and purposes instantaneously in its recognition. The marvel of it all is that future encountering of any one of the sense attributes will be sufficient to bring back the whole ensemble. Thus, hearing the rattle when it is shaken by some one is sufficient sensory stimulus to recall to the mind of the child the whole meaning, so far as it has experienced it, of rattle. This is nature's great synecdoche.

Perception-building illustrated by a lesson in sight spelling. Let us see how the teacher aids her class of first-graders to build up word perceptions. Few if any of them know the names of any letters or words. How shall they be taught to distinguish one from another? Suppose she surrounds herself with all the children beside a blackboard, and starts off somewhat as follows:

Teacher: "I wonder what we saw on our way to school this morning? Who can tell us what he saw? All right, Charles, what did you see?" (Charles enthusiastically tells his experience of seeing a cat chased up a tree by a dog, and of the dog's sitting down by the foot of the tree and barking up at her. After the story has been told and commented upon, the teacher suggests that what Charles saw be written on the board.) By skillful questioning and suggesting she gets Charles to say very simple sentences:

Charles: "I saw a dog."
"He was running after a cat."
"The cat ran up a tree."
"The dog sat down and barked up at her."

(After the sentences have been written slowly and with the full attention of the children upon the meaning of each, the teacher proceeds to drill them in the discriminations of the various sentences.)

Teacher: "Now let us see who can point out all these things on the board. Who can find where it says: 'I saw a dog'? Who can tell where it says 'He was running after a cat'? Who can find where it says 'The cat ran up a tree'? Who can find where it says 'The dog sat down and barked up at her'? Who can tell where it says 'The cat ran up a tree'? etc., etc." (She is helping them to discriminate meanings of words and sentences largely at first through their known position on the board. They are groping about for permanent meanings that they can hold in mind for future identification of the same stimuli. Weeks of drill will be necessary, but slowly the discriminative process will get under way. Some will be slower, others more clever at the game, but all will progress appreciably. Gradually the form of sentences, their *looks*, comes in; then comes appreciation of the form of individual words. D-o-g is identified instantly at this stage with the meaning *dog*. To expedite this process of identification of word form with word meaning the teacher varies her method constantly as the weeks pass and as other stories are written on the board.)

Teacher: "Where is *dog?* Where is *ran?* etc., etc." (She is striving to impress upon them that this symbol means always *dog*, that *eat*, etc. Again grasp of this identity will be slow for some, more rapid for others. Still later she will use another method.)

Teacher: "What word shall I write on the board, Mary?"
Mary: "Ran."
Teacher: "What other words, children?"
Others: "Dog."
"Up."
"Saw."
"Running."
"Barked" etc., etc.

Teacher (erasing *saw*, after warning them to watch carefully): "What word did I erase, Fred?" "Earl?" "Tony?" etc., etc.

Lessons like the above outlined illustrate common methods of building up ready perception of, i.e., discrimination between and identification of, words. This is perforce the primary aim in most of the instruction given in language in the primary grades.

The same procedure is gone through in building up in the classroom the child's perception of numbers. The child must become proficient by dint of long and tedious practice in recognizing and understanding the significance of the various combinations made possible by ten symbols. Most children are able before going to school to recognize or at least understand the meaning of 1-2-3-4-5, and perhaps even up to 10, but comprehension of the significance of larger numbers is built up slowly through drill in reading, writing, and interpreting them.

Laboratory studies of perception. In general the laboratory investigation of facility of perception has been either one of two types: (1) to test the capacity of the subject to perceive a relatively small number of visual symbols when exposed for a brief period; or (2) to identify as many as possible of a relatively large number of symbols in the briefest possible time. We shall illustrate each of these types briefly.

The first type of experiment mentioned involves the use of a piece of laboratory apparatus known as the *tachistoscope*. This instrument is a short-exposure apparatus which has been described briefly in Experiment 14. The exposure cards which are used as stimuli may contain unrelated digits, letters, drawings, etc., and are exposed to the view of the subject for but the fractional part of a second. He must as it were take them in with a single photographic sweep of consciousness and identify them instantaneously, or approximately so. Thus, suppose the unrelated letters

L R T X N K V J

are exposed in this manner before a concentrating subject. He will probably not perceive all eight of the letters, but will perhaps get four or five of them. If, however, instead of displaying unrelated letters we employ meaningful words, the number of letters becomes practically insignificant. Words of twenty-five letters may be perceived in this way. If we employ a simple sentence, as for example:

THE SUN HAS GONE DOWN

the subject will in all likelihood perceive the entire meaning. If we use unrelated digits, as

9 3 7 1 5 3 8 2

only four or five will be distinguished by most subjects, but if we use

1 7 7 6 1 9 2 4

the keen perceiver may observe in the fleeting second of exposure a relationship that will enable him to get every one of the eight numerals. If we employ geometric figures, such as circles, diamonds, oblongs, we shall discover that six or seven of them may be perceived by the same subject who could get only four or five letters.

Cancellation of pied material may be taken as typical of the second sort of experiment, used by laboratory workers in their study of the perceiving process in subjects. Experiment 15 describes a test of this nature. Variations of the type are seen in experiments calling for the cancellation of all misspelled words in a selection. Proof-reading is a practical illustration in point. Experiments with misspelled words in particular have demonstrated to us the fact that when the eyes fixate a word they do not pay equal attention to all letters or portions of it, but seem to pick out, with incomprehensible precision, certain dominating letters or syllables, and before the analytic phase of perception is finished the fusing stage intervenes and the word is perceived in its entirety. It is this fusing tendency that makes proof-reading an exceedingly trying process. From a minimum of discrimination and a maximum of fusion we must now make use of a maximum of discrimination and a minimum of fusing. Study the following illustrations carefully, and note what your own perception experience is initially with each one:

INCOMPREHESNIVE
MISPIRNT
COMPARISON
BELIEVE
CATEGORICALLY

What syllable or syllables did your eyes seem to give greater prominence to? Is the first or the last part of the word the more significant? What letters or syllables were slurred? In the case of the word *comparison* which part gives the cue in reading, the upper or the lower half? Try other similar tests for yourself.

Full meaning of perceptual learning. We may recapitulate what we have been saying concerning perception by saying that perceptual learning consists essentially in the referring of sensory material to the interpretative background which has been built up by past experience, and identifying it by means of the cue or cues thus supplied. The process of perceiving is a dual one; it consists in the first place of the taking in of concrete sensory stimuli, and in the second place of recognizing the meaning of such stimuli through the elucidating medium of memory-images and concepts retained from former related perceptions. To perceive is therefore to comprehend relationships between the sensorially imminent and the memorially past. The profound importance of the part played by the latter may be appreciated when one endeavors to contrast the states of consciousness manifested respectively by a three-year-old child and an intelligent adult in such situations as ‘a sunset,’ or ‘a dynamo,’ or ‘a printed page.’ It is an obvious theorem of the psychology of perception that the more complete and accurate the related perceptions, the more dependable is the interpretative effort of an individual. On the other hand, it is equally obvious that the smaller the interpretative mass the less is a new sensory object raised above the purely sense level. Perceptual learning may, in the light of this, be defined as we defined it at the outset as "that sort of learning which has to do with *recognizing, understanding or interpreting a stimulus which is present to the senses.*"

QUESTIONS AND PROBLEMS

1. How are perceptions of (*a*) space and (*b*) time built up?
2. The psychology of illusions.

3. The psychology of hallucinations.
4. The 'imageless thought' controversy.

SELECTED REFERENCES

1. Freeman, F. N. *How Children Learn*, chapters 8 and 9.
2. Judd, C. H., and Dowling, D. J. *Perceptual Learning.* In the Monograph Supplement to the *Psychological Review*, vol. 8.
3. Swift, E. J. *Mind in the Making*, chapter 6.
4. Strong, E. K. *Introductory Psychology for Teachers*, lesson 9.
5. Warren, H. C. *Elements of Human Psychology*, chapter 7.

Erik [illegible]

3rd test

LESSON 9

ASSOCIATIVE LEARNING

Experiments:

16. *Free association test.* At the signal *S* is instructed to start in with some one word, and to continue to say words as rapidly as he can until the 'stop' signal. *E* notes down the words which *S* gives on a sheet of paper that has been previously prepared with numbered spaces for one hundred words. *E* also keeps a record of the time required by *S* to give the entire one hundred. The only restriction placed on *S* is that he is to say words other than in sentence or sense order. Thus: 'black,' 'white,' 'green,' etc., not 'black horse,' 'runs,' etc. After the list has been given *S* should write up the content and structure of his consciousness, paying particular attention to associative 'links' and the nature of sequences established. Was a series of themes (Jastrow) followed? Were there any auditory or alliterative associations? Were any words repeated once or more? Do nouns predominate? Do concrete words predominate over abstract? What principles of association are exemplified at various points in the series? etc., etc.

17. *Learning nonsense syllables.* After preparing on the typewriter a list of fifteen nonsense syllables, similar in composition to those given at the left, *E* hands the card, face-down, to *S*, with instructions to memorize them as rapidly as he can after the signal is given. *S* should understand that the list may be considered to be 'learned,' for the purposes of this experiment, when it can be just said through without reference to the paper. At the signal *S* turns the card over and proceeds to learn the syllables. *E* records the time taken by *S* in learning. Immediately at the completion of the memorizing, *S* should write up in his notebook an introspective analysis of the learning process involved, placing special emphasis upon any instances of associative cleverness that may have been illustrated in learning the list. If time permits, *E* may prepare, in a similar way, a list of fifteen three-letter sense words, and compare with the results of the non-

B I V
T O J
F U H
T A Q
M E Y
B I H
F E K
N A C
Q O L
R O V
P E J
W I B
Z O D
H A Q
S E B

sense series the time required by S to learn meaningful material, and also the part played by associative processes.

18. *Controlled association experiment: The 'Opposites' Test.* E prepares upon the typewriter a list of twenty stimulus words having easily-thought-up antonym forms. The list is placed, face-downward, before S, with the instructions to turn the sheet at the 'go' signal and proceed to write, as rapidly as possible, after each of the twenty words the word that means exactly or approximately exactly the opposite. Thus: 'good' . . . *bad;* 'enemy' . . . *friend;* etc. E records the time required by S to complete the series. An interesting exercise will be the ranking of all the S's in this and the two preceding experiments in terms of speed and accuracy (i.e., percentage of correct reactions).

full
large
ill
sweet
low
tiny
feeble
dark
joy
gay

ugly
narrow
dull
hostile
simple
clean
crooked
strong
open
sad

19. *Ingenuity test.* For this test E should consult and familiarize himself thoroughly with Superior Adult Test No. 6 (Problem A *only*) in the Stanford Revision of the Binet tests. This test is given, with complete instructions as to procedure, scoring, etc., in Terman's *The Measurement of Intelligence*, pp. 345–48. After S has worked at this problem for the allotted amount of time (five minutes), or after he has solved it, provided less than five minutes were required, he may give Problem B of the same test to E. Neither pencil nor paper is permitted, and each S is to give the solution orally as he works the problem out, thus affording E an opportunity to note down procedure, regardless of whether correct or incorrect. The S's should write out their introspection immediately. (About two thirds of 'average adults' fail to reach a solution of these problems in the limits of five minutes.)

All learning is bond connecting. In the preceding lesson we were concerned with a discussion of two of the four types of learning which are employed with various data to be mastered: sensori-motor, and perceptual learning. In the present lesson we purpose to begin the discussion of the third type: associative learning.

As we have remarked before, all learning, regardless of the type employed, is in reality the connecting of certain stimuli with certain reactions — in other words, the bonding of this situation with that response. In sensori-motor learning, which is typified by the acquiring of some sort or other of skill, the bond thus formed is between either an object and an appropriate muscular reaction to it, or between an idea suggested by an object and the appropriate reaction to it: the process involved is neuro-muscular. In perceptual learning, on the other hand, the bond to be established is between an object and an idea: neuro-muscular response while often a resultant being not an immediate phase of the process. Perceptual learning is purely ideational, and the goal is always comprehension of the meaning of an objective stimulus.

Associative learning represents in a sense a step beyond either the sensori-motor or the perceptual forms, inasmuch as it is purely an intellectual type of learning. Situations involving associative bonding to their proper responses need not be concretely objective, nor is there needfully any neuro-muscular element in the response. In associative learning the bond to be established is always between idea and idea, or ideas of a related nature. The response may be set off either by perceptive or centrally aroused elements. Suppose a sixth-grader reacts to 'a picture of Yellowstone Park' by the response: 'That is in Wyoming.' In this case actual concrete perception of a picture has caused a bond between the idea suggested by the picture and another related idea to function; the child has associated Yellowstone Park with Wyoming, the stimulus being a picture. But now suppose the child reacts to the situation 'See America First,' printed in a tour book under a picture of Yellowstone Park, by thinking: 'I'd like to see 'most any distant place! Wish I could go across the ocean. I'd go to London and see the King! I'd like to go to Holland after that and see the queer wooden shoes. My, and the Dutch children can slide and skate so far!' etc. In this reaction we have a series of centrally aroused bonds: for example, those connecting the Yellowstone with other distant places; those connecting the location idea 'London' with 'across the ocean,' those connecting king with Britain; those connecting various bits of previously associated knowledge about the Dutch people. All these reactions follow in logical order enough from perception of the picture mentioned, but the essence of the process is the strange phenomenon of the tendency of this to suggest that, and that the other thing in consciousness. This ability represents the goal of associative learning: *to remember facts as experienced*. It is perhaps the most conspicuous form of learning in all study of facts which bear relationship to one another. Events of history, geographical knowledge, and scientific classifications are all dependent for their reviving in our memories upon association.

In problem-solving, the fourth and last of the types of learning, the bonds to be developed, as we shall see in the next lesson, are between ideas and idea-groups or principles. Problem-solving is essentially controlled thinking, with a definite goal and toward a definite end. Its goal is the discovering of logical relationships between ideas or percepts, and the discovering or verifying of truths not otherwise demonstrable. Problem-solving as a type represents the acme of human learning; the intellect at work with all its energies and determination in pursuit of the solution of some vexing or challenging problem is engaged in the most sublime adventure upon which it is possible for the mind to embark.

We may recapitulate the different parts played by bonds between the situation and response in the four types of learning, thus:

Sensori-motor learning:	object	....	bond	....	movement
	or idea	....	bond	....	movement
Perceptual learning:	object	....	bond	....	idea
Associative learning:	idea	....	bond	....	idea
	or idea	....	bond	....	ideas
Problem-solving:	idea	....	bond	....	idea-groups or principle

Meaning of the term: Association. All our knowledge tends to be grouped into fields which are more or less distinct. My knowledge about metals, for example, may comprise a wide range of information about various kinds of metals, where they are found in large quantity, of what significance they are in import and export, by what methods they are mined or reduced to a commercial form, etc., etc. Again, my knowledge about lumber may include information concerning the great lumbering regions, methods of manufacture and transportation, kinds of woods best adapted to various purposes, conservation policies and reforestation, etc., etc. All of these bits of information which I possess about lumber or about metals have been acquired through past study, experience or some other means of contact. In haphazard form they would present merely a mass of heterogeneous mind stuff that was sorely in need of sorting. They would be like the cluttered-up and disorderly house in which nothing was in its place and where nothing could be found without an absurd waste of time in searching.

But through the principle of association, our minds are industriously engaged all the time in making a semblance at least of order and unity in the prodigious mass of material that is being continually poured into them. It is this tendency to group related data that is responsible for whatever clarity and coherence of ideas we may possess. In this connection we would be justified in saying that the whole process and program of education are but designed to assist the child in putting together, in the form of ideas in his mind, such facts and principles of the external world as belong properly and naturally together. When a sufficient number of these mental connections have been reasonably allocated, and the learner's grasp is approximately thus and thus, we say he is ready to be promoted to the next higher grade or school. At least, if we do not actually in our systems of grading reduce promotion to this precise mathematical basis, we certainly do make achievement in intellectual range and power the *sine qua non* of advancement up the educational pathway; and intellectual achievement means essentially range and dependability of associations.

Association illustrated by an oriole's song. We may define association as *the process by which one idea calls up another or others that have been previously experienced.* This revival of one through the presence of another idea in the mind we may illustrate in innumerable ways. Our consciousness is a continuous process from birth until death, and for the most part it consists of one idea shading off into another which is in some way suggested by it because it has previously been experienced with it in perception. I hear through my open window the first notes of an oriole's song. But why do I say 'an oriole's'? Why should a few sound waves impinging upon my ear drums suggest to me an oriole? For the simple reason that I have, in the past, associated those particular notes with the oriole. If I allow my thoughts to rule me for a moment I shall associate also with the notes and the oriole the peculiar dangling nest swaying to and fro in the breeze, the peculiarly scrawled eggs, and perhaps the contrast between the dull yellow of the female and the brilliant orange of the male. I may even associate the ornithologist's name, *Icterus galbula*, with the call. In other words, the associative tendency, using the call of the oriole as the nucleus, will if not broken in upon by my will, summon back into the foreground of my consciousness all the information which I may chance to possess concerning orioles.

In the illustration just given all the different associates have been definitely experienced together in past perception and consciously placed in the same grouping: the oriole-ideas. But the sweep of association is much wider and more inclusive than this. The associative mechanism tends also to assemble material in consciousness which did not enter it at the same time nor in the same connection, and we may be amazed often, if we stop to look in on a conversation or a train of thought, to note how this passing from one field to another and another and still another proceeds. Thus, in the case of the illustration just given, hearing the oriole's call might have suggested the notes of other birds; the general subject 'birds' might have brought back to mind the vacation woodland in which I spent a pleasant holiday, and in which the birds were unusually numerous and melodious; recall of my holiday might have suggested the expense connected with it; with this idea of 'vacation expense' might have been associated ideas of 'extravagance,' or 'my salary,' etc., etc.

Thus, from hearing a few bird notes floating in my open window I am borne in a few seconds across numerous other associative fields and finally end up with reflection upon debits and credits. Each associative group overlapped other groups which, while they had not previously been experienced together in actual perception, were selected out of all other possible associates to comprise my momentary chain of thought. There is an interesting game often played in the drawing room known commonly as 'Going on a train of thought,' and which depends for its development upon the immediate associates suggested in a player's mind by a single idea given as a stimulus by the person before.

The mind is a faithful and indefatigable associator. Gradually as the child matures he finds his mental content being comprised of and settling down into systems or groupings of ideas. This holds true no more of his formal knowledge than it does of his character, conduct, and ideals. What he is is determined largely by what he thinks, i.e., the mental connections which he delights in. What one strives after he must first conceive as desirable, and the day by day reconciling of conduct with ideals involves continuous grouping of ideas around the central and impelling desire. The good man is good because his thought associations are healthy; the bad man is bad because his associations are the reverse. What the reformer and the mental hygienist are interested in doing is assisting human beings to revise and regroup their idea systems. In early life, such modification of the associative life is far more easily brought about than in later life, owing to the lesser resistance offered by the neurones. The moral phase of education consists of insuring the right association before there is opportunity for mischief through doubtful or malignant groupings. In the ament, the hardened criminal, and the unprincipled extremist are illustrated extreme instances of dangerous association of ideas.

One's thought associations are then as inexorable as they are unescapable. Surely the writer of Revelation was justified when he exclaimed: "He that is unjust, let him be unjust still; and he that is filthy, let him be filthy still; and he that is righteous, let him be righteous still; and he that is holy, let him be holy still."

The law of association. Not only is it true that all our experiences are grouped in the mind into idea systems; but it is also the case that the recalling of any of these ideas when they chance to be needed or sought after takes place definitely in accordance with law. And even in the case of those lines of thought that pop into the mind, apparently without any associative connection with the ideas just previously entertained, you will find that once you yield to such a train of thought the sequence will be in perfect accordance with this definite law.

Let us illustrate again. As I sit reading at my desk I am suddenly made aware of the fact that a church bell is ringing in some distant quarter of the city. In a flash I am thinking of a little white church of my boyhood village, whence peals of a similarly sounding bell are to this day registered indissolubly in memory. Again I am walking down the hill into the well-remembered valley, seeing the houses and the winding road, and perceiving again the air-laden fragrance of wild roses along the stone wall. People long since dead come out of their homes to nod and smile at me. Companions far scattered walk beside me. The curtain of years is lifted.

What then is this law which operates so profoundly? We may define it thus: *the law of association states that of two* *things previously experienced together, the entrance of one into consciousness tends to bring in the other also.* As we have already seen, our knowledge about anything consists of the sum total of all the varied experiences we have had with that thing. The law of association merely states that the chance or voluntary entrance of any one of these experiences into consciousness acts as a key to unlock all the rest, and they tend to come trooping in also. Note the associations that came back when I heard the oriole's notes; and note the throng of associates that thrust themselves into my memory when the church bell reminded me of the church bell of the village. The percept or the idea which thus acts as a magnet to draw into consciousness all the previously associated experiences we may think of as the 'associative cue.' What do the following associative 'cues' bring into your own mind? My high-school class motto. The coliseum. Paul Revere. Banquo.

Determining factors in association of ideas. On the wall of my study there hangs an old daguerreotype which caught my eye a moment ago. As my eyes chanced to fall upon it I saw, not my study wall, but the wall of the old country 'parlor' on which it was wont to hang when I was a boy. But now surely I have more knowledge associated with 'daguerreotype' than the mere remembrance of an earlier corner where this particular daguerreotype hung. Why did not I think immediately of some such associates as these: other daguerreotypes I have seen; modern photographic processes as contrasted with M. Daguerre's use of plates of silvered copper; an antique bureau in the next room; old family albums; Sir Joshua Reynolds; coiffures of yesterday; 'bobbed' hair of to-day; a collection of old photographs which my friend possesses; or any one of a dozen other associates which I find suggesting themselves to me as I muse about the picture? With all these associates, why did I think first of the country parlor? Obviously there must be certain determining factors governing the recall of associates. Let us see what these determining principles are.

In all our association of ideas certain governing principles operate preferentially; these principles may be enumerated as: *recency*; *frequency*; *primacy*; *intensity*; and mood, or attitude.

The principle of *recency* states that the more recent the association, the more inevitably the recurrence of one will bring to mind the other. Obviously my initial association of the daguerreotype on my study wall with the country parlor could not have been governed by this principle of recency, for so far as I know I had not recently made this association. But suppose I have a grilling examination to pass. If I do not actually 'burn the midnight oil' I certainly get up in the morning betimes in order to go over the whole data again, thus taking advantage of the principle of recency, for if I associate again, say, the Eleatic school of philosophers with the contention that 'change and motion are unthinkable' shortly before I may be called upon to recall it, the probabilities are that, having made the association so recently I shall be able to 'hold' it. The cramming process, in such vogue among certain types of students, would miscarry were it not for the principle of recency.

The principle of *frequency* states that the more frequently ideas have been experienced together the more certainly will the recurrence of one call up the other. One always associates, for example, 6 × 8 with 48 for the simple and sufficient reason that he has been drilled from early school days to make that association invariably. All of our associates that are the outgrowth of drill illustrate the prominent part played by the principle of frequency. My association of 'oriole' with the call notes was due to the same principle. If I see my friend, Black, who is a fireman and always oily and sooty, dressed in a cut-away and wearing a tall hat, I am taken aback, and may even question whether it can be Black: my ordinary associations concerning Black are 'oily,' 'greasy,' 'dressed in overalls and frock.' This violation of the principle of frequency naturally amazes me.

The principle of *primacy* states that the earliest association formed between two ideas may operate when one of them appears subsequently in consciousness. This is doubtless the principle which accounts for my recalling of the country parlor when my gaze encountered the daguerreotype: my earliest childish impressions of daguerreotypes on the parlor wall were very deep, and at times I even dreaded entering the room after dusk because of the fantastic mingling of waning light and deepening shadows on the pictures. First impressions are not uncommonly found to be lasting; hence first associations often persist and take precedence over all others subsequently formed. *M*, for example, was a very poor student and caused her professors no end of trouble during the first semester. Subsequently, however, she 'found herself' and became a very fair student, but her later redemption of herself failed to wipe out the stigma of first impressions, and her professors are more likely than not to associate with her the idea 'a poor student.'

The principle of *intensity* states that the more intense associate will tend to leap in to consciousness when a correlate enters. It may be that this principle of intensity was working with the principle of primacy in causing the memory of the country parlor to come first into my mind when I saw the daguerreotype, thus reënforcing the associate. Certainly my early experiences with the picture, particularly at dusk, were intense enough! An excellent illustration of this principle may be seen in the following association. *H*, who is a returned soldier of the line, would rather go hungry than eat any kind of canned meat! During those gray, grilling days in the trenches overseas, *H* was compelled to subsist very largely on 'bully beef,' as canned meat was commonly called. Some years have passed since that time, but the sight of canned meat is associated invariably with the harrowing life of the trench soldier in *H's* mind. Theoretically he might as naturally associate with canned meat a dozen other things, but the principle of intensity is the determinant, and instead he associates his war experiences.

The principle of *mood*, or *attitude*, states that the particular correlate that is associated with a given idea is sometimes determined by the mood in which the person chances at the moment to be. I may, for example, be busily engaged writing this lesson when a small youngster begins using my study door for a rebounding surface for his ball. My associations will be determined by the mood I am in. If I have been vainly trying for a half hour to think of a good illustration for what I am writing, the probabilities are that I shall hurry to the door and scold the child sharply for disturbing me. I may even order him to put his ball away and play something else. In this case, I have associated with the idea 'child making disturbance' the idea 'naughty child: send it off.' Suppose, on the other hand, I am tired of writing and am pleasantly conscious that it has been going unusually well for some hours. Then with the idea 'child making disturbance' I shall be likely to associate the idea 'dear little fellow: I'll play with him.' My attitude of mind has made a surprising difference in the nature of my associations.

These five principles, recency, frequency, primacy, intensity, and attitude, are always operating to guide my associations. Whichever one happens to be the stronger in any given situation will determine what idea connections shall be made. We may say then that our associations follow the law of least resistance, and that the weakness of the resistance is as the relative strength of the strongest of these five principles.

Association by similarity. We have already defined the law of association thus: of two things previously experienced together in consciousness, the entrance of one into consciousness tends to bring in the other also. This explanation of association is obviously sufficient in cases where the ideas associated have been *contiguous*, i.e., have actually occurred together in previous perception or thought. The law offers a sufficiently obvious explanation of why I associated with the memory of the village church bell the people and the environs of the village: I had often experienced them together. So with my association of the daguerreotype with the country parlor, etc. But why should the ringing of the city bell suggest to me instantly the village bell and its associates? I had not previously experienced these together. And why should I exclaim when I meet Mr. A for the first time that he resembles my old friend, Mr. B, so strikingly? I have never before associated these two gentlemen together. Or again, why should the story you are telling remind me of another story that I should like to tell? Or why does this countryside which I am experiencing for the first time recall to me that countryside that I have seen often before?

Until recently psychologists have been wont to explain associations of two experiences not contiguous in past consciousness by the law of similarity, implying thereby that an experience may revive another experience because of its similarity to it. Somewhat recently, however, psychologists have felt that what appears to be the operation of a law of similarity is in reality only the law of contiguity at work. Let us illustrate by the very common experience of a stranger's striking reminder of one's friend. Suppose one meets such a person and forthwith is reminded of a friend. What takes place is something like this. Some feature of the stranger you have experienced before in your friend, although the totality of the stranger's features you have not so experienced. In other words, your idea of your friend is an aggregate of ideas in which, say, a characteristic shape of face is included. And now, of a sudden, you perceive in some other person that same characteristic shape of face. Naturally then that feature recalls the other setting in which it has been so often experienced, and you are reminded of your friend. It is plain that this association, apparently by similarity, is merely association by contiguity, some element breaking away from the present idea-group and by virtue of the principle of frequency gathering to itself its customary associates.

Fig. 25 represents Professor Judd's method[1] of illustrating association by similarity. Inasmuch, however, as the similarity is a conclusion which we reach *after* the process of association, and is not the cause of it, it will be best if the student refrain from thinking of similarity as a law of association.

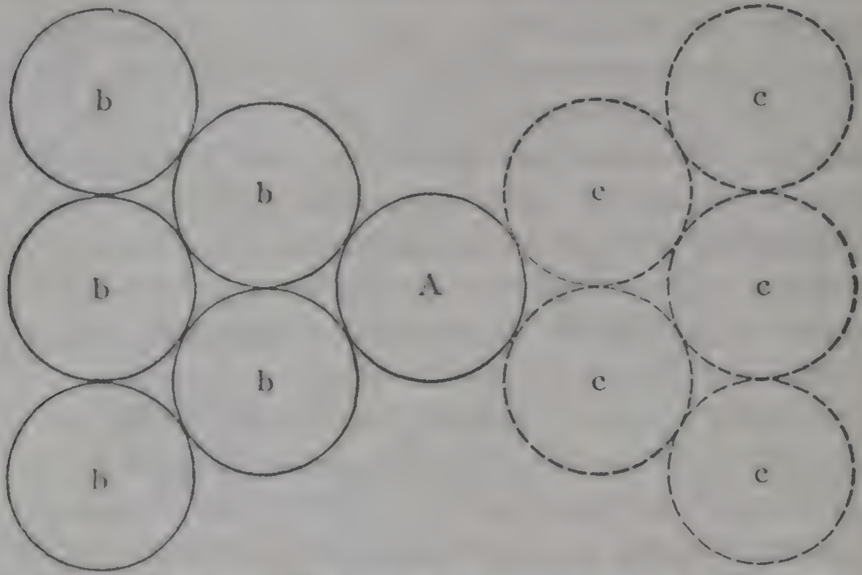


FIGURE 25. JUDD'S METHOD OF ILLUSTRATING ASSOCIATION

The full-drawn circles represent the elements of the present experience. Of these elements *A* attaches itself also to the system of elements represented by the dotted line circles. *A*, when taken with the circles *bbbbb*, constitutes the present experience; *A*, when taken with the circles *ccccc*, constitutes the recalled experience. *A* is obviously the center of relations between the two systems. **(Reproduced by courtesy of Charles Scribner's Sons.)**

Rise of new association series. We have already made note of the fact that the succession of ideas entering the mind depends upon the principle of recency, frequency, intensity, primacy, or mood. Such is the case obviously only after a particular ideational series has been started. Thus, when one is thinking over the occurrences of the vacation trip it is perfectly comprehensible that one idea recalled should suggest another and another and still another in a long series. But what induces one to change the trend of his thoughts? Why should one find himself weeks afterward living over in the world of ideas the experiences through which he passed? Or, once having set about recalling those experiences, what is it that makes it possible for him to break in upon the train of ideas and initiate an entirely new and unrelated series? Fortunately he has two sources of release from an ideational series, one of them objective and the other subjective. Let us illustrate the first of these.

---

[1] Judd, C. H. *Psychology*, p. 235.

As I walk slowly along a suburban road, musing thoughtfully about, let us say, the Nebular Hypothesis — although it might just as well be about any other thing under the sun — my attention is all at once drawn to an unusually beautiful hedgerow of lilacs in full bloom. Straightway I pause to enjoy the fragrance and beauty thus encountered, and for some minutes my train of ideas is concerned with lilacs, or hedges, or landscapes. If a companion is present, I shall very likely exclaim with him over the picture presented, and may linger long by the roadside. But after a brief time I shall be ready to continue my walk, and I may or may not reinstate the original train of ideas concerning world dust which was interrupted by the beholding of the hedgerow. Suppose, for example, I become aware of an approaching shower; the likelihood is that I shall hasten my step in order to return home before the storm is upon me. We may conclude, then, that one of the common means of interrupting one train of thought and interposing another is *actual perception of some object unrelated to the immediate train of thought.* This perception starts a different group of associations thronging into the mind, and they for the time being at least displace the preceding series. The nature of consciousness is such that the stimulation of a sense organ may be sufficient to arouse associative processes. This predisposition to perceptual stimulation is the objective means of interrupting a train of thought.

But we are not fortunately at the mercy of our sensory environment: I am not forced to wait to perceive some other objective stimulant before I can divert my thoughts from the lilac hedge. True, the gathering storm did act as such a monitor of my ideational processes, but I could have arbitrarily limited the amount of thought-time which I gave to it. I might even have passed the hedgerow by without more than a passing thought of its beauty. Implicit within his brain cells man has a will power which enables him to *select* what ideational processes he shall release, and he may exercise this power by willing not to pay attention to *this, which is imminent*, but to attend to *that, which is remote.* The very fact that I was ruminating upon cosmic dust before I encountered the hedge is proof of my capacity to initiate idea-trains quite independent of the sensory environment of the moment. Thus is man master of time and circumstance. It is this power of initiating ideational processes centrally which constitutes one's second, or subjective, means of interrupting a train of thought. Man's whole grand panorama of thought-life is constantly unfolding: sometimes he is compelled to focus here; sometimes he focusses as it pleases him.

Knowledge and idea. Ideas are either revived percepts or else a recombination of them, possessing the quality of associating with themselves other related ideas. But what is knowledge? Merely the sum total of the ideas possessed by the individual about a given thing. I may have an idea, i.e., a reproduced perception, of a horse, or of a spectroscope, or of my typewriter, or of a hairy Ainu. But my knowledge of horses is not limited to my idea, i.e., my memory, of a single horse. My knowledge of spectroscopy is not limited to an idea of a triangular prism. My knowledge of typewriters is not limited to an idea of my own typewriter; nor is my knowledge about the hairy Ainus confined to a single picture of a group of them that I may chance to possess. Knowledge is a comprehensive system of ideas which is determined in its completeness by the relative fewness or the relative abundance of the idea elements, and in its practical dependability by their unity and orderliness of arrangement. We have one knowledge of electricity, and one knowledge of democracy, and one knowledge of mathematics, and one knowledge of magnetism. That is to say, our knowledge of electricity, etc., is comprised of all our ideas concerning it and represents a unity in our ideational experience.

From this viewpoint, it is easy to speculate philosophically as to the purport and end of the educative process. It becomes a matter of tying together in the conscious experience of the child-student those items of man's past heritage and present accomplishments that society deems best worth while perpetuating in the lives of those who are to come after. If such is the end of education, it is a corollary to it that the whole problem of pedagogy is to discover and put into operation those methods which will accomplish this end most economically and with the promise of the greatest returns in human citizenship.

As we saw a moment ago, all ideas are arranged essentially according to the contiguity of their reception, and when any one of them is recalled the others tend also to be recalled. The significance of this fact for education is profound. Whatever things are to be associated together, and so thereafter appear together, must first be *experienced together in a state of attention.* This is the very keystone of the arch of knowledge. Much of the work of all teachers consists in providing a stimulating 'milieu' wherein their students will of and through themselves, as largely as possible, assemble the elements of knowledge in an orderly and efficient manner. In its truest sense education is a sifting and a sorting going on constantly in the midst of a challenging adventure in search of unities and relationships.

Importance of rich primary perceptual experience for children. As we are aware, knowledge is comprised of ideas: ideas are revived perceptions or their combinations. We may infer from this that the richer and more comprehensive the perceptual experience, i.e., the experience with the world of objects and principles at first hand, the more natural and accurate must the retained ideas be. One who has had little experience may be ranked as low in the scale

Ideas come from past
[illegible]

of ideas. The great poet, the great engineer, the great statesman, the great philosopher — all owe their greatness in considerable measure to the breadth and depth of their experience. So with any one who is to have large sympathies, wide interests, deep understandings: he must have rich primary experience with life.

It is the case, however, that not always in the history of educational practice has this fact been clear in the minds of those who sought to educate. Too often and in too many lands the work of the schools has been centered largely in contemplation of the cold skeleton of knowledge, it being a common impression of the past that children could not reason out problems for themselves under twelve years of age, and that memoriter work with them possessed the double advantage of supplying them with knowledge and also of strengthening the faculty of memory!

Rousseau[1] was perhaps the earliest of the educational reformers to state clearly the importance of direct contacts with the world of objects and to anathematize the widespread emphasis placed upon memorizing by late eighteenth-century teachers. He writes in the *Émile:*

> In any study whatever, representative signs are of no account without the idea of the things represented. The child, however, is always restricted to these signs without ever being made to comprehend any of the things which they represent. We imagine that we are teaching him a description of the earth, but we are merely teaching him to know maps. We teach him the names of cities, countries and rivers, but he conceives them as existing nowhere save on the paper where they are pointed out to him.
>
> All that enters the human understanding comes through the senses; the first reason of man is a sensuous reason, and it is this which serves as a basis of the intellectual reason. Our first teachers of philosophy are our feet, our hands and our eyes. To substitute books for all these is not to teach us to reason, but to teach us to use the reason of others; it is to teach us to believe much and never to know anything.

---

[1] Rousseau, J. J. *Émile.* Tr. by Payne, pp. 75 ff. Cf. also Parker, S. C. *History of Modern Elementary Education*, pp. 193 ff.

In consequence of his convictions as to the importance of actual contacts on the part of the child-learner, Rousseau includes in his ideal system of education for Émile, during the years from five to twelve, only such things as will make for education through the senses. Comenius and Locke, before Rousseau, and the Pestalozzians after him, made this matter of sense perception the foundation stone of their educational theory. De Guimps[1] reports thus a class in geography taught by Pestalozzi at Yverdon:

> The first elements of geography were taught us from the land itself. We were first taken to a narrow valley not far from Yverdon, where the river Buron runs. After taking a general view of the valley, we were made to examine the details until we had obtained an exact and complete idea of it. We were then told to take some of the clay which lay in beds on one side of the valley, and fill the baskets which we had brought for the purpose. On our return to the castle, we took our places at the long tables, and reproduced in relief the valley we had just studied, each one doing the part that had been allotted to him. In the course of the next few days more walks and more explorations, each day on higher ground, and each time with a further extension of our work. Only when our relief was finished were we shown the map, which by this means we did not see until we were in a position to understand it.

What a refreshing method of teaching land formations! Your best modern teacher would go about it in much the same way. Unfortunately, however, not all teachers nor all superintendents have sat at the feet of Pestalozzi and learned wisdom of him. The danger of getting words for actual experiences is scarcely less great to-day than it was a hundred years ago when Pestalozzi first showed teachers how to teach. Many a teacher still is what Pestalozzi characterized as a 'wordy fool,' substituting the letter for the spirit of knowledge. Textbooks used unintelligently; scarcity of reference material; uncertainty on the teacher's part as to what constitutes the true aim of study; the human tendency to follow a *laissez-faire* policy along the lines of

---

[1] De Guimps, R. *Pestalozzi, His Aim and Work*, p. 326.

psych — may we learn [illegible]
[illegible] "passage" [illegible]

least educational resistance — these are chief among the causes for symbolistic education, just as they were in the days of the great Swiss schoolmaster. Children still are taught glibly to recite meaningless definitions and to rehearse unintelligible word facts. The equator is a line drawn around the center of the earth; the north and south poles mean little; angles and triangles and rectangles and parallelograms exist only as geometrical drawings on paper; tables of weights and measures apply only to academic problems in a textbook; parallels and zone lines possess little significance; arithmetical principles and procedures have no counterparts in the world of men and affairs; pages of history are but a dead record of a dead past, having no connection with the present or significance for the future; physiology is only remotely and occasionally seen to touch life; even the manual arts are often quite unrelated to practical and useful lines; drawing is frequently stereotyped and formal copying of artificial sketches and designs, rather than the spontaneous and natural reproducing of objective models. The remedy for all this is obviously the substitution of objective methods in education just as far as possible for the time-honored but profitless veneration of words and symbols.

Modern methods of objective teaching. The essence of modern educational method is then the provision of a maximum of experience with the realities, and the reduction of purely verbal learning to a minimum. Only through such emphasis upon perceptual experience can the learner build up a system of associative knowledge that he can trust and respect. The world of ideas from this viewpoint is seen to be but a counterpart and a reflection of the world of objects and experience. Schools become not institutes for memory training through exercise, but rather workshops, laboratories, and reference rooms wherein knowledge is *discovered*, rather than *imbibed*. Geography exists no longer as an encyclopædic dictionary of the earth and its countries and their political and civic divisions. It becomes a fascinating

[illegible]

quest after developments and trends and evolutions and the principles which underlie them. Vital problems of human living together and working together and sharing together are to be investigated, and truth thus come upon. The teacher who throws aside textbooks as such and creates a spirit of inquiry and curiosity is teaching with something of the skill and the vision of the true teacher. Why has the city of Chicago grown so phenomenally in the last half century? What are the comparative advantages of New Orleans and Mobile for the Gulf trade? In a fuel emergency what are the probabilities of the United States being able to import coal from other countries? Such problems as these entail in their investigation actual research. Learners thus set at work in the spirit of investigativeness, with a clear objective, will not only amaze their elders often but, more than that, will be establishing intellectual habits and attitudes that will be a benediction to them later on. The associations which they form will be clear, logical, and faithful, for their ideational systems will be reproductions of the world of objects and processes.

Wilson and Wilson,[1] commenting upon the futility of word learning as compared with objective experience, give an interesting illustration of the evils of the former:

> Commissioner Claxton tells of a pupil who came into his office while he was superintendent of the city schools at Goldsboro, N.C. In classifying this pupil the suggestion was made that she should carry geography. The pupil indicated that she had finished the geography. Desiring to test her ability, she was asked to locate the Appalachian Mountains. She immediately responded, 'The Appalachian System is the highlands in the eastern part of the United States, extending in a northeasterly and a southwesterly direction from Maine to Georgia.' Following the work further, the pupil was asked if she had ever seen any part of the Appalachian System. She immediately replied that she had not, when as a matter of fact she was at that time on the very ridge of the Appalachian System.

---

[1] Wilson, H. B., and Wilson, G. M. *Motivation of School Work.*

> The point to this illustration is that the geography work has usually been conducted in such a way that the pupil makes no connection between the facts as recorded in the book and their objective existence. Pupils read about the great round ball which floats in the air, and may even go out and look for it, but they never suspect that this ball is the earth upon which they constantly walk. In fact, we have come to take such a formal attitude toward the geography work that the majority of teachers are satisfied to have the pupils read what 'the book' says, and then give it back, parrot fashion. With streams and the action of water within easy reach, these subjects are studied from the book alone, without any reference to the first-hand material. . . .

All this that we have been saying about objective methods of teaching merely means that ideational knowledge, which is obviously the goal of much of our education, is most economically, most lastingly, most meaningfully, and most gratifyingly built up from contact with the world of objective experience. Association of ideas means, as we have said, connecting of related ideas into idea systems. This connecting is rendered more permanent as well as more trustworthy if it comes about as the result of perceptual experience. In the case of geography, this basis in experience may be provided through pictures, map-study, illustrative stories and magazine articles, collection and displaying of products, arrangement of exhibits, visits to industrial plants, field trips, hand work and construction work illustrative of periods or processes, reference work in the sources, study of ticket books, route maps, local surveys, etc., etc. In arithmetical processes, it is probable that two thirds of the time can and should be given to learning through the hands and the eyes. Pad and pencil and measuring-rod and tools should be at the least as actively used as answer-books and thumbed pages. Civics, hygiene, history, nature study, and most if not all the other studies of the curriculum can be thus built up upon the sure basis of concrete experience.

Too often the learner makes his associations between a page and a sentence, neglecting and often all unconscious of the material world of things and experience which is mirrored in the symbols.

In Lesson 10 we shall continue our discussion of associative learning, and add to it a study of problem-solving as the fourth and last type of learning.

QUESTIONS AND PROBLEMS

1. Demonstrate by illustrations the fact that association by *contrast* or by *cause and effect* is really association by contiguity.
2. Make a list of several associated ideas which appear to have come into your mind as a result of the operation of the principle of (*a*) frequency; (*b*) recency; (*c*) primacy; (*d*) intensity; and (*e*) mood, indicating which of the five was the determining factor in each case.
3. Write out the train of ideas suggested to your mind by some such associative 'cue' as a picture, a person's face, a bouquet, a chirping cricket, etc.
4. State the distinction between perception, image, memory, idea, and knowledge.
5. Write a reminiscent paper on the subject: "Words in place of contacts in my own school experience." Pay particular attention to wrong notions, hazy ideas, and false impressions which you received in connection with any of the subject-matter connected with this or with that study.
6. Write out the procedure you would follow in teaching a lesson on one of the following topics: New York City; the cotton fields; islands; the scarlet tanager; the house fly; popular vote; Captain John Smith. Indicate what the children are assumed to know already about the subject, if anything, and the grade for which your suggested procedure would be fitted.

SELECTED REFERENCES

Consult the references given at the close of Lesson 10.

Reasoning [illegible] at all.
attempted (memorize) make connections
+ [illegible] meaning
to it.

LESSON 10

ASSOCIATIVE LEARNING AND PROBLEM-SOLVING

Arbitrary and logical association. There are certain bonds of connection which we often find it desirable to establish that are built up but slowly. Repetition after repetition, it may be under stress of strict concentration and a strong determination to remember, commonly fail to impress the connection indelibly enough to render thereafter the operation of the law of association inevitable and invariable. There are, on the other hand, still other connection bonds which are established with a minimum of attention and repetition, and which never fail to function. Who of us finds it taxing to associate Paul Revere with the midnight ride, or red hair with Smith, or Franklin with electricity, or London with England? And who of us would not give much if he could forever blot out certain associations that recur anon out of the experience of his past, and which were formed almost spontaneously? It is of these two different kinds of associative bonds that we are to think for a moment.

Those associations between which the learner is able to discover no rational connection, no significant relationship, are termed arbitrary associations, and it is these which are most difficult to form. Associative cues in such data possess no inherent and logical community of reference, and must needs therefore be dependent on sheer mechanical repetition. And even large numbers of repetitions of the association often fail to impress them permanently. In laboratory experimentation upon the learning process, data of this unrelated sort are commonly used to investigate the comparative efficiency or speed of learning of several subjects. They possess the obvious advantage over logically related data of being practically meaningless, i.e., suggesting a minimum of relationships; hence they constitute a very satisfactory measuring-rod of sheer ability to learn and retain apart from all past experience which might exert some influence on some subjects if the data employed were meaningful.

Suppose, for example, it is desired to test the time required by various subjects to learn a given datum. The experimenter proceeds to make up a series of nonsense syllables which he uses on the material to be learned. Syllables of this sort are commonly constructed by inserting a vowel between two consonants; thus:

Tij — laz — puv — cip —lic — def — kol — zut — mub — nof

If Subject A requires 70 seconds to bring a series of nonsense syllables just over the threshold of memory, so that he can repeat them once without referring to the list, while Subject B requires 140 seconds, we are justified in concluding, so far as this particular test can show us, that the former has twice the learning speed of the latter. Suppose both subjects are asked to recall the series twenty-four hours after learning, not taking occasion to think of them in the mean time. If it should develop that B recalls more of them than A — which is not likely — then we should conclude that while B learned more slowly he retained better than A. If neither could remember the entire list we could obtain still another index of their learning capacity by finding out how long each would require to relearn the series. These are but two or three of the different ways in which logically unrelated material is commonly made use of in experimental education.

In our everyday life we very commonly have to do with such relationships that have no logical connection, but which it is highly desirable in the interest of economy that we be able to remember. One such common association is a telephone number. I may call Mr. S—— every day for years, and still be compelled to search for his number in the telephone book every time I desire to reach him. The reason is, obviously, that there is no logical relationship between *Mr. John Smith* and *Valley* 29864–1. True, it may chance that Mr. John Smith lives in a valley — or on a hill — and that he may be 29 years old, or 98, or 64, and that he is unmarried, therefore single, therefore there is only one of him! If such be the case a simple mnemonic may help me. But more likely there is no such discoverable relationship between him and his telephone number, and I can resort to no artificial device, which might after all be more cumbersome to hold in mind than the number itself. If, finally, in rebellion at the time wasted every day in finding Smith's number, I resolve to learn the thing by sheer concentrated repetition, I shall doubtless succeed ultimately. But if I have dozens of telephone numbers which I call often it will be a difficult task indeed to accustom myself to them all, and I may give it up in despair and revert to the telephone book when I want a number.

Another connection in our daily experience which we often find it difficult to establish is such a one as *John Smith* and *1283 E. 259th Street*, there being again in this case no rational relationship between the person and his street address. Other illustrations of the necessity for the establishment of sheer arbitrary associations through repetition are to be met with in plenty in the realm of scientific classification, as, for instance: a certain small moth which the biologist associates with the family *nadata gibosa;* a common flower which the botanist classifies as *epigæa repens*, etc.

Logical associations preferable to arbitrary associations. It is evident from what we have just said that by far the more dependable and economical associations are those which are logical and meaningful. Sheer verbal associations are likely to be not only extremely short-lived, but also meaningless. It should therefore be a matter of concern for every student, whatever the nature of the material he is striving to master, to be consistently and indefatigably on the lookout for significant connections in meaning between this and that datum. To be content with verbal association where logical relatedness might be built up is always the index of an intellectually lazy student, or else of one who has failed utterly to grasp the real meaning of study. One of the primary functions of the teacher should be to see to it that in every field of inquiry meanings and relationships result in the learner's mind rather than verbal glibness. An illustration or two will be interesting.

Toward the close of the school year recently, in accord with custom, all eighth-grade school children in one of our western states were given a final examination in physiology. The following are some typical answers taken from the papers turned in by the eighth-graders in one of the best educational counties:

> A common disinfectant is small-pox.
> Mastication is what is going on.
> Epidermis is a certain kind of medicine.
> The diaphragm is another name for backbone.
> The bones are made up of hard mucous membrane.
> Pericardium is something that will put you to sleep.
> Respiration means all the different juices in the body.
> The diaphragm is very delicate and located in the head.
> Fumigation is when the air is shut off and death may come.
> The Eustachian tube is a tube running all over the body.
> The nervous system is a kind of tube where the blood vessels are in.
> The process of digestion causes headaches and much impure blood.
> Fried potatoes often cause digestion.
> A disinfectant is anything you catch by going where they are.
> Measles and chickenpox are disinfectants. When you have them you should stay in the house and keep warm and try not to give them to others. Pimples on the face are not disinfectants, but some kinds are.

It is perfectly obvious that the absurd statements made by these children were made because they did not understand the things that they had learned, or rather memorized. No logical, meaningful connections had been established between, for instance, 'fumigation' 'and fumes' and 'fumes deadly to germs.' Instead, the pupils had sought to associate verbally, with the result that when it came to recall, the verbal associates got mixed up, diaphragm going with backbone, measles with disinfectants, disinfectants with contagious diseases, etc. The children were completely at the mercy of sheer verbal memory, which is a highly uncertain servant. Even granting that the definitions asked for in the examination paper were within the proper knowledge of eighth-grade children — which of course is absurd in itself — it is not hard to infer from their ridiculous statements wherein the method by which they learned (?) was improper. It would be stating it too mildly to say that the hours spent in the study of physiology by these boys and girls were wasted: they were worse than wasted, for far from being as poor intellectually as they were before, they are actually poorer, inasmuch as they have been perhaps hopelessly and irrevocably confirmed in decidedly impoverishing intellectual methods and habits of study.

An illustration of logical learning. The following is a good illustration of logical learning as opposed to verbal memorizing. An adult reader of *The Outline of Science*[1] found it desirable to learn the names and characteristic features of the six periods of the Palæozoic era. As given by Professor Thomson, they are

Palæozoic Era	Permian Period
	Carboniferous Period
	Devonian Period
	Silurian Period
	Ordovician Period
	Cambrian Period

After the gentleman had learned the facts concerning this particular era of geological time that he desired, he was asked by the writer to give an account of the procedure which he followed and the methods employed. He had studied the data in question without any suspicion that he was ever to be questioned as to the method which he used, his whole purpose having been to learn the names and characteristics of the several periods for purely cultural purposes. Following is the gentleman's account of his learning process:

---

[1] By J. Arthur Thomson.

> After I had read pp. 91–98 thoughtfully, I resolved to learn their contents so that I should always remember them. At first I thought I would just say them over and over until I knew them by heart, but I was certain this way of doing it would not be satisfactory, for after a few days or weeks I should forget them unless I kept reviewing them often. Besides, I not only wanted to remember the names of the six periods, but also the characteristic forms of life and development in each of them. So I began to look for associations that would help me. I remembered that in college we learned the order of colors in the spectrum, red, orange, yellow, green, blue, indigo, and violet, by making a name out of the initial letters: Roy G. Biv. In a twinkling I had it: "*Cut out slang during class, please!*" (A request once actually made by one of the professors, irritated at the inelegant speech of members of the class. We laughed so long and loud then and afterward over it that the incident has always been fresh in my memory.) So far, so good. I turned my eyes away and found I could say all six of them, in order from the first to the last: Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian.
>
> Now for the meanings. The text stated that only sponges, jellyfishes, molluscs, and backboneless animals existed during the Cambrian period. It would be easy to remember this, for the Cambrian was the earliest period of life and since life began in the seas it was necessarily elementary, and jellyfishes and sponges are representative spineless and elementary forms of life. In the Ordovician period, it was stated that the first true fishes (i.e. having backbones) were evolved. The name 'Ordovician' suggested to me, *fisch*, and *vische*, which I happened to know were the German and Dutch names, respectively, for *fish!* I could easily then remember that 'Ordovician' was the age of 'fishes.' In the Silurian period, the first attempts to get out on to land were made by the fishes. This entailed the development of a rudimentary lung in order to breathe dry air. Lung fishes and mud fishes developed this specialized inside breathing area. The name 'Silurian' I easily connected with 'lung' because of the 'lur' in it. This would help. But naturally if the golden age of fishes passed with

the Ordovician, the following period must be in some way concerned with land life, and since land life evolved slowly it seemed natural to me that in the Silurian age there could be but the merest beginnings of dry-land living, which would of course be represented by mud fishes, wallowing about in muddy water along the shores. The Devonian period was marked by the first amphibian and the appearance of flowering plants upon the earth. Since in the Silurian period the conquest of the dry land had been limited only to mud fishes jumping about the shore, it seemed natural that in the Devonian the next step of actually getting out on to land for a considerable period should be taken. That meant the amphibians. And if they went on to land there must be food to attract them; that meant the beginnings of vegetation. In the Carboniferous period came gigantic forests of enormous horsetails and club mosses, with myriads of insects. It was also the golden age of amphibians and the scene of the setting of the stage for the earth's deposits of coal. Coal was naturally connected with carboniferous, and this gave me the key needed. What was coal originally? Pulp and débris of forestation. What kind of forestation? Obviously, vegetation of a rank growth: horsetails and club moss. The Carboniferous period connected up nicely with golden age of Amphibians, because in the preceding period (Devonian) amphibians appeared in some quantity, and in the ensuing age they might logically be expected to reach their golden age. Myriads of insects must have existed as food supply for them. The Permian was the last period of geologic antiquity, culminating in an ice age. Vegetation changed to ferns and conifers. Reptiles appeared. Since this was the *last* period, there must be some sharp difference between it and the preceding to prompt geologists to mark it as the end of an era. That great change could be easily remembered as a change from fostering warmth to extreme cold. That would imply a sharp change in vegetation: from mosses to conifers. Reptiles were explainable on the ground of their complete emancipation from the water, which would be the most logical development beyond the amphibians.

I find that, while it has been some months since I have read the account, I can easily recall any of it in a few seconds.

The above represents an excellent illustration of learning through logical association of ideas. The gentleman in question might have spent hours in trying to memorize the facts contained in the section mentioned, and then have forgotten most or all of them within a week. Instead he spent only a very short time, reacting thoughtfully as he read, and striving always to tie up the new data in some logically connected way. Not only did he succeed excellently in being able to retain and recall them, but — an equally significant fact — he experienced fascination and satisfaction in the process of impressing them. There can be no doubt that he took considerable conscious pride in his method, and was aware of an increasing power and mastery as he proceeded with the learning. Had he gone at his task arbitrarily, learning the facts verbally, far from deriving any such pride in achievement he would have been in grave danger of sacrificing his own self-respect. It goes without saying, of course, that other students of the Palæozoic era would have formed strikingly different associations, each bringing to the new data presented his own individuality and his own fund of experience.

Getting a lesson. Bonds built up between ideas logically associated are much more readily and permanently established than bonds whose only connection is arbitrary repetition. A single thoughtful impression is often sufficient to guarantee a permanent bond in logical association. This fact serves to emphasize the importance of reducing arbitrary verbal association in school work to a minimum, and raising logical association to a maximum. Unfortunately, however, this principle is reversed in our classrooms, and we find the premium placed upon arbitrary associating of ideas. As McMurry [1] has pointed out, the average student inclines to regard 'memorizing' as the nearest synonym for the term 'studying.' Among the reasons which he assigns to the prominence given to verbal learning of this sort are: (1) that memorizing is more superficial than real thinking, and people are naturally too lazy intellectually to dig into things; (2) that memorizing is erroneously believed to be a strengthener of the memory faculty; and (3) that memorizing is commonly believed to precede rather than follow thinking.

---

[1] McMurry, F. M. *How to Study*, pp. 161 ff.

All this, of course, is quite wrong, and it is not the pupil's fault so much as it is the teacher's, or the system's. Many a recitation (i.e., a reciting of what has previously been read or said) is conducted purely as a question-and-answer dialogue. What the text says must be repeated more or less literally. Many an assignment is given as so many pages to be studied, no worthy attempt being made to elaborate upon the meaning of 'study.' Pages of history, or geography, geometrical theorems, arithmetical procedures must all be given back verbatim through the mouths of the pupils. In such conditions the pupil has no resource save to *learn*, i.e., *memorize*. His immaturity and lack of perspective render him an easy victim to the question-and-answer teacher. School work becomes dead. Naturally inquisitive minds grow dull and passive. The educational pathway stretches unenticingly over a monotonous plain which is more like an arid desert than a promised land flowing with milk and honey. In such an atmosphere and before such a prospect the best of pupils can hardly be expected to wax enthusiastic.

What is it, then, to 'get' a lesson? It is to be confronted not with a book but with books. It is, in short, to search diligently — even enthusiastically — after a solution. It is to make intelligent use of sources, be they books or maps or persons or what not. It is to interpret, compare, weigh, judge, conclude, arrange. It is to neglect words and magnify meanings and relationships. The question-and-answer teacher asks: "What sort of climate has Denver?" Her pupils reply, parrot-like, "Denver has a cool, dry climate." They have 'got' their lessons as a plate 'gets' the picture to which it is exposed. In the classroom of the other sort of teacher it is discovered by the children that tubercular people often go to Denver. Forthwith comes the query: "Why?" Immediately comes the search through the sources, and the answer is found. They have 'got' their lesson as man has always done, by searching diligently after truth. The association is not formed between a page and a sentence, but rather between ideas and principles logically related.

Clearly, if courses of study are to be completed on schedule there will hardly be time for the pupil learners to become investigators, and rediscover for themselves all the wisdom and the lore that mankind has amassed in thousands of years. Searching requires more time than rehearsing. Consequently one of two courses will have to be followed: either we shall be compelled to limit sharply the amount of time that is to be given to pupil research, and continue to devote the major portion to the conventional textbook method, or else we must revise and reorganize the course of study in such a way that it can be covered. As between the two, for the present teachers will be compelled to push their children along at a rather rapid rate, permitting them to delve into investigation and research all too little. We should not lose sight of the fact, however, that educational method is by no means static or inviolable, and that we are only beginning to learn how to bring the learners of every age in contact with the racial storehouse of experience. The day will come when we shall be more intelligent and skillful in our manipulation of the educative process, and it is not too much to believe that not only will courses of study be so arranged that every subject will be entered upon by pupils as an interesting field of investigation, but, as a result of truer educational concepts, more abundant sources, more tangible goals, and finer correlations, much more rapid progress will be made by the learners. In the mean time the teacher of vision and faith will strive without ceasing to bring in this educational millennium in her own schoolroom.

To 'get' a lesson is rather to be inspired with the spirit of quest than to be forced through a system of word absorption.

Association and habit. In a sense we should be justified in concluding that association of ideas and habit are identical. Thus, once having associated 'cool' and 'dry' with 'Denver,' or 'Louis XVI' and 'Marie Antoinette' with the 'French Revolution,' or 'diamond mines' with 'South Africa,' we shall always thereafter so associate them, in accord with the principle of habit. Why should not the bond between 9 × 8 and 72 be just as truly the result of habit as of the association of ideas? Is not repetition, which as we know is essential for the forming of a habit, also under the title of 'frequency' operative in association? In the broad, it is true, habit and idea associations are thus similar. Strictly speaking, however, a distinction should be made by the student between these two types of response, as we pointed out in an earlier lesson (see p. 91). True habits are neuro-muscular in character; i.e., the bonds linking them up are between nervous tissues and muscular tissues, and involve definitely physical response. Idea groups, on the other hand, are strictly the results of bonds established between brain cells, and involve definitely ideational response. Thus, writing '72' with the typewriter consists essentially in physical response, and involves habit; thinking '72' however, consists essentially in ideational response, and involves the association of ideas.

The line of distinction between habitual and ideational response is not always a sharp one, and it very often happens that a response is unclassifiable as belonging to one type or the other, partaking somewhat of the nature of both. Thus, the engineer jumps to his throttle and brakes when a red light flashes before him out of the darkness. Is it because he associates 'red' with danger, or because he is in the habit of so responding when such a situation arises? The probabilities are that both the idea 'danger' and the 'movement toward the levers' occur almost simultaneously. If such is the case we might conclude that physical movements and idea associations may often be different aspects of the same response. But even so, it is clear which aspect is physical and which is ideational, howbeit both merge in the total response.

Problem-solving or reasoning. Problem-solving embodies undoubtedly the highest and most complex forms of learning. Sensori-motor acquisition is, as we have seen, essentially the linking of appropriate motor responses to specific sensory stimuli; perceptual learning involves the processes whereby the learner familiarizes himself with the significance of the present stimulus. Associative learning consists in the bringing together in conscious experience of several groups of data in accordance with certain definite laws and principles. But in problem-solving the learner is placed definitely on the offensive. Given a perplexing situation, how shall I think my way out? This represents eminently the essential nature of the most complex of all forms of acquisition. Before going into a discussion of problem-solving, however, we shall do well to understand that this type of learning does not exist in isolation from the three other types, but is ordinarily brought into functioning in connection with them. (At whatever point in a learning process, be it primarily sensori-motor, perceptual, or ideational, the learner is confronted with the necessity of reaching a conclusion, he becomes a problem-solver, a thinker, a reasoner.)

If we extend the expression "learning process" to include life itself, which is a continuous learning process, we can appreciate better the significance of problem-solving. What vocation shall I enter? What credence is to be given to this or that argument? What is the basis of this report, or of that rumor? For which candidate shall I vote? What shall be my attitude on this or that question of the day? For what shall I spend my money? How shall I keep my bodily efficiency at the highest point? These are typical problems that everybody faces, whether or not he possesses the force of character to think them through and conduct himself accordingly. The animal, as we have noted, goes at his problems in the trial-and-error way, solving them if they are relatively simple, but helpless before them otherwise. At the opposite extreme of learning is the typically human procedure of concentrated and intelligent study of principles and relationships, with a definite conclusion to be arrived at. At its best, such rational study gives man control over mighty forces, evolves enlightened social and political theories, establishes sound economic and sociological principles; on the other hand, equally great power to do and spread evil. There are both constructive and destructive geniuses.

Two interesting studies in problem-solving methods. Of the large number of investigations which have been made into learning processes involving problem-solving, we shall refer here to but two. The first is an investigation by Ruger[1] of the process of learning to take apart mechanical puzzles. As we should expect, all of the twenty-seven subjects participating at various times had recourse to the trial-and-error method of the animal, now trying this solution, now that, and repeating the same random and pointless movements time after time, even after the realization of their ineffectiveness had come. Some of the subjects, naturally, used the trial-and-error method more persistently than others. Some strove before attempting any great manipulation to study the problem presented, and to discover the nature of the underlying difficulty of removing or assembling the parts of the puzzles. Power to envisage a situation was often weak in the subjects, few of whom were able "to construct mentally in any completeness the spatial transformation required." In practically all of the cases random manipulation played some part and, in many cases, a very considerable part in the gaining of success.

Another interesting study of problem-solving is that by Cleveland[2] on learning to play chess. In this of all games, the ability of a player to infer the plan of his opponent, to construct a plan of his own, and to think his way out of a bad situation gauges his cleverness. The entire game is a series of knotty problems, possessed of almost innumerable possibilities. Cleveland found from his inquiry (which was in the form of a questionnaire) that the beginner scarcely ever thinks of his opponent at all, but devotes his whole attention to his own moves. Notwithstanding this concentration upon his own pieces, he persists in overlooking many possibilities in his early planning and suffers irreparable losses in consequence. Often his plans are worthless, both in the advancement of his own conquests and in the safeguarding of his major pieces. He makes apparently absurd blunders in his moves. There are, of course, wide individual differences in chess ability, some players very soon becoming able to plan ahead four or more moves, others rarely ever reaching that degree of ability. Says Cleveland: "The mental qualities most utilized in chess-playing are . . . power of accurate analysis, strong constructive imagination, and a power of far-reaching combination. . . ." These are qualities which are essential to all special aptitude for learning of the problem-solving type.

---

[1] Ruger, H. A. *The Psychology of Efficiency*. Archives of Psychology, no. 15, June, 1910.

[2] Cleveland, A. A. "Chess"; in *American Journal of Psychology*, vol. 18, pp. 269–308.

What these studies indicate. These investigations suggest several facts concerning the problem-solving process which we may assume more characteristically apply to child learners than to adult learners. In the first place, we can be pretty sure that immature wrestlers with problems will tend to make excessive use of the trial-and-error method of reaching solutions. To envisage a situation rationally and consciously to bring to bear upon it the interpretating background of experience, aided by persistent use of constructive imagination, is more strikingly an attribute of the mature and experienced than of the immature and inexperienced. The fact should not be lost sight of, however, that not all persons of rich experience are able to apply the fruits of such experience with any great amount of nicety to new situations. Nor is it always the case that immature persons are as inefficient in the meeting of their problems as one would expect from their limited background. Perhaps about all we can say is that, as a type, the mature is somewhat less at the mercy of trial-and-error methods of procedure than the immature. In terms of the schoolroom situation this would mean that children in the mass are more inclined to random procedure than adults, younger children than older children, etc.

In the second place, we may expect pupil learners to make blunders, to be limited in their thinking, to be unlikely to make coherent and unified plans of attack, compelled as they are in the early stages of any learning process to concentrate their energies largely on 'getting the step.' Thoughtfully planned and logically integrated analysis of a problem cannot take place until certain fundamental habits specific in it have been achieved. Applied to the learning process, this means that in the early stages of learning of the problem-solving type the learner is perforce concerned largely with familiarizing himself with technique, accustoming himself to the peculiar nature of the problem, and in general 'limbering-up' to it. After these early stages have passed, the individual proceeds rather rapidly toward whatever maximum psychological possibilities he may individually possess. Cleveland found this true of chess-playing. We have all found it true in our own personal experience with geometrical or other mathematical problems, with problems in physical and natural sciences, with problems in history, sociology, and indeed in connection with any other subject of study pursued in the problem way. We must 'learn the ropes' before we can climb.

Finally, the teacher must always take into consideration the question of individual differences. Perhaps no two people will set about the solution of a problem in exactly the same way, nor will achieve identical results psychologically. This individuality of the learner is, as we shall see later, a fortunate thing for progressive scholarship, and the wise teacher will see to it that, instead of its being spoiled under the stress of her own narrow methodology, it is fostered in every legitimate way. Education suffers still from the curse of the lock step.

What stimulates one to reason? So long as races and individuals remain in a state of savagery they do very little purposeful thinking. The environment in which they live is very simple in most of its aspects. Complexities attendant upon civilization do not exist. Primitive peoples are organized on a low level, both socially and industrially. Problems of finance, of government, of labor, and of economics confront them so rarely that the need for careful and sustained study along any particular line is never pressing.

But as the ramifications of civilization begin, problems appear; and as the degree of civilization increases, there is a corresponding increase in the number, range, and difficulty of the problems with which mankind is confronted. Modern twentieth-century society is more highly organized and its parts more intricately integrated than has ever been true in human history. This very complexity of social organization means problems to be solved, principles to be established or discarded, theories to be originated and tried out, pure knowledge to be applied, valid conclusions to be reached.

But what stimulates the individual to tackle such problems as these? What is it that spurs one on to depart from lines of least resistance and do purposeful and sustained thinking? The answer to these queries may be found in this simple statement: One thinks with a purpose (i.e., reasons) when he is conscious of a need that he desires to satisfy. This at once opens up the whole world of business, both private and public, the whole question of life and lifework — in short, every conceivable situation in which one is ever confronted with the necessity of satisfying a need. The child anxious to construct a kite that will actually fly; the young man or woman facing the question of what college to choose; the graduate facing life and the necessity for selecting a calling; the captain of industry whose plant is falling behind in production — these are but two or three of the innumerable kinds of problems, of human needs, that must be solved by individuals everywhere.

The only worth-while life is a life which contains its problems: to live without any longings and ambitions is to live only half-way. Since this is true, and since problems are always arising in the lives of most people, it follows that one of the supreme aims of the school should be to emphasize and dignify the reflective method of study to the end that future problem-solvers may not only learn to work thoughtfully and systematically toward a conclusion, but also to find satisfaction and enjoyment in the process. There is no stronger stimulant to the growth of self-respect and self-confidence in any individual, be he young or old, than the feeling of conscious pride that attends the successful solving of a problem which vitally concerns him.

In this connection the interesting contrast should be pointed out between social or community problems and personal or individual problems. In general, personal needs lead more directly and easily to active thought than do social ones. It is much more natural for a man to study his tottering business from every conceivable angle against an impending failure than for him to grapple with the problem of providing free school lunches for impoverished and undernourished children of the slum district. On the lower civilization levels mankind tends to limit his thinking to the circumference of his own personal needs; on the higher levels he inclines to reach out in his thinking beyond the bounds of his own individual longings, and to embrace in it the needs and desires of humanity. Howlers for 'their rights,' whose din is as insistent as it is continuous, belong in the one category; pleaders for the social weal and the common good belong in the other. In the teaching of childhood and youth this contrast between the selfish and the social should be more apparent, both through wise teaching of the social subjects of the curriculum and through the affording of abundant opportunity for pupils to share in the government and general conduct of the school community.

In school work, problems arise most clearly in connection with number work and mathematical processes. Thus: A man spent three fourths of his money and had five dollars. How much money had he at first? Here there is a definite goal to be reached, and it can be reached only by rational thought. But, as we have seen, the problem method of attack can equally well be employed in connection with many other subjects, notably spelling, geography, history, science, physiology, literature, provided only the classic textbook notion be thrown aside and courses of study be arranged in a way to stimulate real thinking. This of course does not mean that all learning should be in the form of problem-solving. We have referred in previous lessons to the importance of drill in various subjects where certain bonds need to be reduced to the automatic level. The problem-solving type of learning bears no relation to lessons whose aims are drill. Besides its inapplicability to drill lessons, the problem method is unsuited for exclusive use in any subject. Much of real interest and enjoyment often attaches to the simple reading of descriptive and narrative references in history and other subjects which would be lacking wholly in continuous search after explanations, causes, etc. Younger children in particular will react most happily to the educative process which is based rather largely on illustrative and descriptive elements. As they grow older and advance upward through the grades more and more attention may, however, be given to the setting and solving of problematic questions.

Two age-old methods of solving problems. Whatever the pedagogical aspects of the thought process, mankind has evolved two methods of procedure in the solution of his problems: the method of *induction* and the method of *deduction*. In the former procedure, he passes from individual observations to a general conclusion, as for example when having noted that two blocks plus two blocks make four blocks, two apples plus two apples four apples, two pennies plus two pennies four pennies, etc., the child makes the inference that two plus two of anything always makes four. In the latter procedure, one starts with the general principle and applies it as a possible explanation of the individual observation, as for example when from his general knowledge the child classifies this bird as a robin, or that insect as belonging to the family of lepidoptera. Speaking from the point of view of teaching, we may say that the inductive lesson is in the nature of an inquiry which aims at the discovery of general knowledge; while the deductive lesson seeks to stimulate the class to employ or apply general knowledge.

These statements suggest at once the very intimate relationship between the process of induction and deduction. As a matter of fact, instead of thinking of all rational knowledge as the product either of induction or of deduction, we should rather think of it as the product of both these processes, since a high degree of certainty in reasoning can only be reached when both are in operation. In order to generalize we must first have access to a large number of particulars; and once a general truth has been thus established, we use it as a new hypothesis to explain other particulars. For example, suppose a teacher in giving a lesson on nouns guides the pupils through a process of noting the nature of individual nouns in a sentence on the board, in a reading-book, or in a conversation. After some time devoted to this study the children are in a position to formulate what appears to be a definition of a noun. The lesson has been inductive in that it has taken into consideration the nature of a large number of individuals and from them has drawn a generalization. Suppose next day she sets about her language lesson differently, and instead of studying individual words with an idea of discovering wherein they are similar she gives the pupils a list of words in which nouns, pronouns, adverbs, conjunctions, etc., occur indiscriminately, and asks them to identify all the nouns;

this lesson has been deductive in that it has involved the application of general conclusions previously made to new individuals. So we might illustrate inductive and deductive lessons in arithmetic, spelling, nature study, English, geography, history, etc., the former seeking to aid the learner to define and generalize, the latter to stimulate him to classify and identify.

The four formal steps in induction. The Herbartian school have suggested four formal steps that are found helpful in the planning and teaching of an inductive lesson. These are (1) Preparation; (2) Presentation; (3) Comparison; (4) Generalization. (5) application

In the first of these steps, *preparation*, the teacher prepares her class for the reception of the new knowledge to be presented, first by making them conscious of a need to solve a problem; and second, by encouraging them to recall to their minds such apperceptive background as they may possess which will help them to understand and assimilate the new knowledge to be presented. For example, the teacher who is about to teach an introductory inductive lesson on the multiplication of decimals will meet the requirements of the preparation step perhaps by: (1) creating in the pupils an appreciation of the importance of one's being able to check up the interest entries in his bank-book, and (2) by encouraging them to recall what they already know about relevant arithmetical processes. The amount of time given to the preparation stage in inductive learning depends upon the nature of the new material, the extent of the past relevant experience of the pupils, the comprehensiveness of the teacher's aim, etc. In consequence, it may occupy but two or three minutes, or it may extend through several class periods.

The second step, *presentation*, consists of the actual teaching of the new material to be learned. The old-fashioned teacher took the initiative in this step and presented orally the new information, the pupils serving merely as passive recipients. Newer notions of good pedagogy condemn this so-called 'lecture method' and suggest that in so far as possible the pupil shall take the initiative and learn for himself. Consequently, observation or study of objects, the performing of experiments, excursions, field trips, study of reference books or other sources, critical comparison and evaluation of data, etc., etc., may all be justly included within the range of the step in inductive teaching. In general any process whereby new knowledge is presented to the mind belongs within the province of this second step in the inductive lesson. Many teachers are compelled partly through lack of time, and partly because when working independently children are prone to overemphasize the irrelevant and the unimportant, to present the new knowledge in the lecture fashion, believing in this way that they can save time and place the proper emphasis. While there is an element of truth in this, the fact should not be lost sight of that what is told is much less likely to be understood than what is discovered, and that the process is much less interesting in itself.

The third step, *comparison*, consists of the selection of those elements in the several individuals studied which are common to all. If, for example, a class is studying the nature of the paragraph inductively, its members will be given access to several well built paragraphs, and through active comparison of them will be able to pick out the common elements, as, for example, mechanical elements like indentation, and rhetorical elements like topic sentences. In the study of the French Revolution, similarly, after the pupils have learned in the presentation step that the masses had been long subjected to the arrogant will of the nobles, they compare their condition with those of the English masses under Charles I, the American colonists under George III, the Russian serfs under the czars, etc., and find similar conditions obtaining and similar revolutionary results accruing. Tyranny, long efforts to overthrow it, and final success are common elements in revolutions.

In the fourth step, *generalization*, the results are summed up into a general conclusion or rule or principle. Thus, to conclude that tyrannous government leads to revolution is the logical summary of the preceding steps passed through in inductive study of the French Revolution; that event is, in other words, one of several related historical events which have all resulted in revolution. Similarly, hypotheses like the following are arrived at as generalizations from the study and comparison of related individual facts: rivers have their source in highlands; all sentences are begun with capital letters; water freezes at about 32° F.; in the multiplication of decimals, point off as many places in the product as there are in the multiplicand and the multiplier; it is wrong to steal, etc.

Advantages and disadvantages of the inductive lesson. The method of induction possesses the distinct advantage of leading the child to create his own knowledge, and so stimulates the investigative spirit and the scholarly attitude. It is also true that knowledge worked out by induction appears to be a more permanent acquisition of its possessor than knowledge which is supplied *ex cathedra*. Junior and senior high-school pupils very commonly fail to observe the margin when writing, to begin proper names with capital letters, to use correct punctuation, etc., and yet they have been told to do all these things time and time again by their teachers. There is good reason to believe that knowledge which they discover for themselves through diligent searching will be more surely built into their lives than will information which they receive passively through the ear.

As we have already noted, however, the inductive lesson takes more time than teachers can afford for most of their lessons. There are two other limitations of this method. In the first place, the material to be learned does not always possess logical value, and attempts to treat it inductively fall flat. For example, as Miss Earhart[1] points out, "to try to derive a lesson on table manners or morals from the story of *Alice in Wonderland* is absurd." In the second place, much of the material to be studied is well worth knowing, but hardly of sufficient importance to carry beyond the step of presentation. The fact remains, however, that more use should be made of the inductive method in those subjects and lessons in which logical relationships can be discovered and generalizations induced.

---

[1] *Types of Teaching*, pp. 52, 53.

One danger in the use of induction should not be overlooked. Untrained and immature minds making use of it are prone to make the 'inductive leap' too quickly; i.e., they are likely to generalize from too few instances. The scientific mind is not hasty in establishing hypotheses: it collects and compares large numbers of individual facts, and only presumes to generalize after all probability of exception has been reasonably ruled out. In making use of induction with young people it is particularly important that they shall be made to appreciate the importance of this painstaking search after truth through the accumulation of large numbers of individual observations.

The fifth formal step: deduction. We have seen in the preceding paragraphs that induction consists in building up general truths from particular observed data. Deduction, on the other hand, consists in explaining a particular observed datum by referring it to some general principle already known. The Herbartians made the fifth formal step in the inductive lesson the *application* step, i.e., the step wherein the pupil applied the generalization arrived at in the fourth step to the interpretation of new related particulars. Having, for example, established the hypothesis that a fraction may be reduced to its lowest terms by dividing both the numerator and the denominator by the largest number that will exactly divide both, the pupil is set to work actually reducing fractions to their lowest terms in accordance with the rule. This bringing to bear of a general truth upon a particular situation is known as the method of deduction, and a lesson in which the general abstraction is led up to inductively and then tried out concretely is often spoken of as an inductive-deductive lesson.

In everyday life instances of deductive reasoning are to be found on every hand. Weather predictions, disease diagnoses, legal findings, judgments of character in applicants for positions, matters of personal conduct, opinions, etc., must all be dependent upon the bringing to bear of some general truth upon concrete and individual situations.

In the schoolroom, deduction is similarly made use of wherever the learner seeks about him for rules, principles, axioms, or generalities that will aid him in reaching the solution of a problem. Thus new knowledge is built up and classifications are made which did not previously exist in the mind of the learner. In some cases it is a very simple matter to bring a new problem under its proper general classification, as for instance when the algebraic law: "*The square of the sum of two quantities equals the square of the first, plus twice the product of the first and the second, plus the square of the second,*" is followed immediately by a half-page of problems involving the application of the rule. More often, however, the learner must ransack his past experience and decide for himself which hypothesis is to be applied to the present circumstance. Thus, in solving the problem: Why is whale's blubber a staple food among the Esquimos, the following hypotheses might be tried, but only the last could be accepted: Whales are very large; whales are not eaten commonly by other people; whales' blubber would otherwise be wasted; Esquimos like blubber; Esquimoland is cold and blubber will keep well; whales frequent northern waters and are commonly hunted by Esquimos.

Four steps in the deductive learning process. In the deductive learning process we may distinguish four steps: first, the awareness of a problem to be solved; second, the search after possible hypotheses; third, the final acceptance of a satisfactory hypothesis; and fourth, verification of the hypothesis accepted.

So far as the first of these steps, awareness of a problem, is concerned, we need merely say that the exact nature of the problem must be clearly understood by the student. Thus, the question, "What conditions make New England a great textile manufacturing center?" presents a clearly stated and very definite problem, which can be plainly understood. The difficulty with much of the deductive work projected by teachers for their pupils lies in the haziness and indefiniteness of the problems which they present. If young people are to learn to handle laws and principles they must be very clear indeed in their own minds as to exactly what it is they are trying to do.

The second step in the deductive process, search after hypotheses, involves the summoning to his aid of one general truth after another by the student, and the discarding of those which he feels to be inadequate. In the case of the problem as to what conditions make New England a great textile center, inferences like the following might be thus tried: New England is one of the oldest sections of our country; New England receives many immigrants; most of the New England states border on the Atlantic Ocean; New England lies in the temperate zone; etc. All of these hypotheses are statements of fact, but none of them will hold water as major premises of a syllogism. To contend that all older sections of a country contain extensive textile industries; or that a large influx of immigrants is essential to the production of cloth; or that sections bordering on an ocean are important weaving regions; or that location in the temperate zone is an essential condition of textile development — all of these are improbable, and the student upon examination is compelled to dismiss them as general principles.

The third step in deduction, the final acceptance of a satisfactory hypothesis, follows naturally from steps one and two. Sooner or later a general truth will suggest itself which satisfies the student as a reasonably plausible solution of his problem. Thus, when the student tries out as a major premise the principle that abundant water power is a prominent factor in the location of textile mills, he finds a plausible explanation of why New England is a great textile manufacturing center. He may be uncertain as to whether that single fact is of sufficient weight to offer a complete solution of the problem, and may cast about for other general principles which will suggest other factors back of the textile supremacy of New England.

No teacher has had very long experience with children — and older students, too — who has not observed the naïve and often absurdly irrelevant explanations they offer as solutions of specific problems with which they are confronted. To the question: "Why are cattle ranches found so commonly in Texas?" the answer is suggested, "Texas is the largest State in the Union." And to the question: "Why is there probably no life on the planet Venus?" the answer is given: "Venus is so far away from the earth." It is of the highest importance, therefore, that young people be taught to examine with care the inferences which they propose rashly and thoughtlessly. They should be led to appreciate the importance of careful search after hypotheses and the value of critical examination of them.

Verification as a final step. Having finally selected the one hypothesis which seems rational, the final step is *verification* of it. In mathematical problems, as for example the division of fractions, the rule can be tested out by actual and visible proof. But in problems in other fields which cannot be reduced to mathematical exactness, proof of a theory is not always so obvious. Often one's feeling that he has reached a proper solution is about the only demonstrable proof of an hypothesis. If by comparing his solution with the standards adopted or approved by others he finds that it stands the test, he may be still more convinced of its correctness. If he finds no ideas or factors in conflict with his results he may rest reasonably assured of their accuracy. Books, opinions of others, and the world of experience become essential sources of reference in the search after deductive hypotheses that will apply in the solution of particular problems. Often, it is true, pupils grope hopelessly and blindly about in search for general principles which will give solutions. This is especially the case with the immature and inexperienced mind. As skill develops, however, the teacher will find less and less need to take the initiative, and may restrict her activities to occasional guiding, suggesting, and criticising, bearing always in mind of course that each step in the deductive process is to be passed through earnestly and thoughtfully by her students.

Miss Earhart's summary[1] of the deductive lesson is well worth inserting here:

> The teacher is cautioned not to attempt the omission of the deductive process in order to hurry the pupils forward to correct answers. Pupils need training in reasoning quite as much, or even more, than they need some of the answers. They need assistance and patient treatment while exercising the different steps of the process. The suggestion is made that the teacher guard against excessive employment of deduction in his own teaching procedure, that is, against trying to force into use general forms of knowledge for which the pupils are not prepared. It is also suggested that pupils be led to use freely the underlying ideas they already possess in the mastery of new situations. We must guard against two evils in connection with the employment of deduction; namely, trying to use general principles before the pupils possess them, and, secondly, omitting to use them when pupils do possess them.

Importance of motivation and interest in problem-solving. As we have seen, no problem is ever attacked by the ordinary run of folks unless a real need of reaching a solution is felt. The school child, from the very nature of things, can hardly feel keen necessity in discovering why the French Revolution occurred, or why New England has large numbers of textile mills. At best, any interest aroused by good pedagogical methods in the solution of problems of this sort, remote as they are from the experience of children, can be but a somewhat artificial product. That does not mean, however, that no effort should be made to make the process interesting. Too much of our school study consists of mere compulsory application to the book, and has in it little to inspire burning intellectual eagerness and zest for discovery and achievement in the realms of intellect.

---

[1] *Types of Teaching*, pp. 67, 68.

It is hard to think of a finer service teachers could render, either to their pupils or to society, than that represented in a taste for and some proficiency in the attacking and solving of problems. If this is to be done, a tremendous amount of thought and planning must be devoted to the teaching process. Old textbook methods will have to yield place to the presentation, or better still, the active discovery of problematic situations which shall be so arranged and interwoven with the general aims and content of the educative process that they will possess, for children at least, a reflected grandeur and fascination from the great world of life just beyond the school environs.

QUESTIONS AND PROBLEMS

1. Prepare an inductive lesson plan for teaching the multiplication of a decimal by a decimal. After your plan is completed, compare it with one included in the appendix of Miss Earhart's *Types of Teaching*. Wherein is your plan weaker or stronger?
2. Prepare a deductive lesson plan for teaching why, when it is noon in Cleveland, it is one o'clock in Boston and eleven o'clock in Denver.
3. Enumerate several instances in which the 'inductive leap' was made too soon. How can this tendency be avoided in the schoolroom?
4. State the advantages and disadvantages of the inductive lesson. The deductive lesson.

SELECTED REFERENCES

Dewey, John. *How We Think.* (General reference.)
Earhart, L. B. *Types of Teaching*, chapters 5 and 6.
Freeman, F. N. *How Children Learn*, chapters 10 and 11.
Kirkpatrick, E. A. *Studies in Psychology*, chapter 5; pp. 95–107.
La Rue, D. W. *Psychology for Teachers*, chapter 12.
Pyle, W. H. *The Psychology of Learning*, chapter 6.
Strayer, G. D., and Norsworthy, N. *How to Teach*, chapter 7.

[illegible] [illegible]

LESSON 11

INITIAL PHASE OF LEARNING: IMPRESSING THE DATA

1. Free and Forced Attention

Experiments:

20. *Free and forced attention.* For this experiment two selections, similar in nature to those given below, are to be read aloud slowly and distinctly by *E*. Selection A is to be read first, after which *S* should repeat orally and as accurately and fully as possible what he heard read, and immediately write out a brief introspection as to the nature and structure of his attention during the reading. The same procedure should be followed with Selection B. To avoid any possibility of *S* having familiarized himself beforehand with the selections given herewith, it is suggested that the instructor substitute other selections, being careful that the one is easily provocative of interested attention, and that the other necessitates the use of conscious effort to comprehend. If two sets of selections are supplied, *E* may subsequently assume the rôle of *S* in the experiment.

> *Selection A.* One day, while walking in a field, I nearly stepped on two snakes. They were passing each other, traveling in opposite directions, and not more than two or three inches apart. Suddenly one of them, as he squirmed along, jostled against the other. Forthwith the first snake swung about and, grasping the other's tail in his fangs, began to swallow him alive. Seeing his predicament, the victim also swung about and proceeded in turn to devour the tail of the other. As I watched, in fascination, the circle formed by the two angry snakes, pitted against each other in gastronomic desperation, grew smaller and smaller and smaller, until, suddenly, each heaved a mighty last swallow and — *incredible dictu!*— disappeared down the other's throat!
>
> *Selection B.* "Many opinions have been given on the value of life. Some call it good, others call it bad. It would be nearer correct to say that it is mediocre; for, on the one hand, our happiness is never so great as we should like, and on the other hand, our misfortunes are never as great as our enemies would wish for us. It is this mediocrity of life which prevents it from being radically unjust."
>
> (Stanford Revision of the Binet Scale, *Superior Adult IV*, *b.*)

21. *Attention under conditions of distraction.* Prepare two digit-

[illegible] [illegible] + attention.
Interesting because you [illegible]

meaning of attention + interest-

symbol test sheets, with different keys, and supply each student in the class with one of each. If they are available, Healy's test,

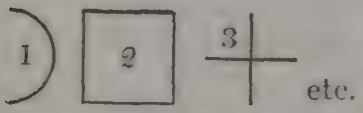


FIGURE 26

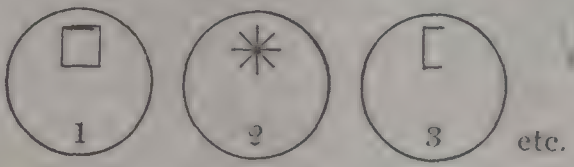


FIGURE 27

No. 31032, (see Figure 26) and Pyle's test, No. 31027, (see Figure 27) (C. H. Stoelting Company) will be handiest for this experiment, but the instructor may construct his own keys with equally good results. Divide the class into two equal groups, balanced as accurately as possible as to learning capacity. Let Group A practice the Healy test for five minutes under distraction, then the Pyle test for a similar period without distraction. Next let Group B practice the Healy test, for five minutes without distraction, then the Pyle test for a similar period under distraction. Find the average performance of Group A for each test and compare with the average of Group B for each test. A loud-ticking metronome or a continuously ringing electric bell will supply the needed distraction. Each student should write up an introspective analysis of his behavior in the notebook under and without distracting influence.

22. *Range of attention.* For an experimental study of the range or span of attention, the instructor should previously arrange a number of small objects on a cardboard, being careful to have the card concealed during the giving of the instructions. At the signal the card is exposed for not more than a second, after which it is again covered. The observers are immediately to note down the names of as many of the articles perceived as they can recall, and then to write out their introspections, bearing in mind especially the following items: were all the objects recalled actually attended to individually during the exposure, or do you think the eyes 'photographed' some of them, as it were? What objects are you confident you actually perceived? Did your attention 'take in' several articles at once, or only one? What associative consciousness had you?

Attention a selective and a neglecting function. In the last three lessons we have been considering the various types of learning: sensori-motor, perceptual, associative, and [illegible] Learning

problem-solving. In this and the next lesson we shall consider the stages passed through in any learning process, whether it be sensori-motor, or perceptual, or associative, or problematic learning. There are three such stages: (1) impressing the data; (2) retention of the data; and (3) recalling the data when wanted. This and the two following lessons will be concerned with the first of these. Lessons 14 and 15 will be devoted to a study of the two others.

The initial stage in learning anything involves attention or mind focus upon that particular thing. If I am to learn to write (sensori-motor type), I must attend to form and execution; if I am to interpret the meaning of an objective stimulus (perceptual type), I must direct my attention upon it; if I am to learn facts which belong together (associative type), I must concentrate upon them and experience them together in a state of attention; if I am to reach conclusions and make logical classifications (problem-solving type), I must focus my attention on principles and axioms involved. The first law of learning anything is the law of attention.

Attention must be thought of primarily as a *selective function* of consciousness. Theoretically the mind of a sentient individual is open to the reception of any and all stimuli that impinge momentarily upon his sense-organs. Actually, however, the mind is so constituted that it is not completely at the mercy of circumstance. It possesses the power, out of all the multiplicity and diversity of stimuli that play upon it, to select more or less voluntarily those particular stimuli that it wills to attend to. In the case of selection among objective stimuli we may illustrate the process in this way. In the park there are a great number of interesting and fascinating things to greet the eyes and ears and nostrils of the sauntering observer: trees, flowers, shrubs, hedges, grass, lanes, ponds, bridges, birds, swans, fishes, and the like. To which shall he attend? Obviously, since his range of simultaneous attention is limited, he cannot attend to all the bits of beauty at one time: he must select. He may select in a purely haphazard manner,

[illegible]

1st [illegible]

noting now this shrub, now that swan, now this flower bed, etc., in the order in which he encounters them. He may, on the other hand, possess a particular interest in trees, and pass quite through the park paying little heed to any other objects. In either case, he is attending to one thing at a time, and he is unconsciously or consciously selecting that thing out from its setting for definite observation. During those moments of absorption over a given object he is, relatively speaking, quite oblivious of other contiguous objects.

The case is no different in a train of thought, save that the stimuli here are centrally aroused ideas rather than objective things: the mind selects, or may select, out of its storehouse of ideas and memories those particular ones to which it is desired to attend. For example, in a social gathering, the conversation may be very general, and I may attend now to ideas brought into consciousness by what this individual says, now to those released by what that individual says. Very likely, given my cue by some remark or other, I shall give voice to some of them. The conversation may, on the other hand, turn upon some important topic of the day, like Mr. Wells's *Outline of History*, in which event I shall marshal my own ideas definitely about that suggested topic. In either case, as was true when the stimuli were objective, I am attending to one idea-group only at a time, and I am unconsciously or consciously selecting that idea-group out from among others. During the time in which I am absorbed over a given idea-group I am, relatively speaking, quite oblivious of other contiguous ideas.

But attention is likewise a neglecting function. In walking through the park one encounters several different bits of beauty, but he can attend to only one of them at a time. Which one of them he will select at this moment of consciousness and which at that moment will depend upon several factors — uniqueness, interest, mood, etc. The actual selection, however, whether it be voluntary or spontaneous, necessitates neglecting for the time being all contiguous objects and concentrating on the one selected.

Attention — a selective function [illegible]

So with attention to subjective processes: in selecting one idea or idea-group for attention, I perforce must neglect all other central processes. To attend, is, then, to select, and by the same token to neglect. The more immature or undisciplined the mind of the one attending, the more difficult it is for it to rule out all irrelevant idea-groups and compel attention to the line of thought determined upon. On the other hand, the more the mind has been habituated to faithful and consistent attending to predetermined lines, the easier it is for it to disregard the irrelevant and maintain itself in steady pursuit of its goal. The attention of the younger child is caught now by this, now by that compelling stimulus, and he is in large measure at the mercy of circumstance; the trained thinker, on the other hand, aims tolerably accurately at the solution of his problem, and is able to direct his thinking sublimely past ambushes and pitfalls, in a straight course to the desired outcome: he knows how to neglect, having first selected.

Wastefulness in study. Professor Betts, writing on the general subject of attention, likens[1] the power of the mind in the attentive state to the sun's rays when they are passed through a lens and conveyed upon a bit of paper: forthwith the paper bursts into flame. So with the concentrated mind: when it is converged upon a line of thought the brain becomes energetic and dynamic and results must needs be attained. But when it is allowed to ramble hither and yon from one point to another the results achieved are likely to be worthless, exactly as the sun's rays, so long as they fall unfocussed through the pane, will lack energizing and consuming force. The concentrated mind in a very peculiar sense is endowed with power. This phenomenon can be demonstrated by the reaction-time experiments in the laboratory, close attention to the reception of the stimulus invariably resulting in an appreciably shorter reaction time than is the case when the observer is only passively attentive to the stimulus.

---

[1] Betts, G. H. *The Mind and Its Education*, p. 71.

Attention · Summary Clearness

It is a fact, however, that not all students know how to focus their attention unreservedly upon the work in hand and keep it there until tangible results have been achieved. Perhaps the greatest handicap of pupils is this common lack of control and direction over their thought processes. Various factors obviously enter into poor or uncontrolled attention. With one pupil, it is a general lack of sympathy with the task in hand; with another, it is unawareness of how to study carefully and thoughtfully; with another, it is a confused idea of the goal to be reached as a result of having studied; with still another, it may be inability to resist distracting stimuli, either objectively or subjectively arising; and with still another, a general mental sluggishness and torpor — traceable often to some physical or nervous tension which renders him totally incapable of collecting his thoughts and turning them full-flood upon the present task. Any of these influences, working singly or collectively, at one time or another, may wreak havoc with the attentive state, dissipating and scattering the pupil's thoughts in a dozen different directions along present lines of least resistance.

In the light of this somewhat wide-spread lack of good habits and attitudes of attention, it is clear that the learner who is to make progress in any type of learning must resolve to select by and for himself what he will attend to, and to neglect or reject such irrelevant stimuli as have no bearing upon the present situation. To work while one works and play while one plays finds no more significant interpretation than it does in this connection. If the task of the moment be reaching the solution of a problem in profit and loss, the only attitude that will advance the worker of it will be one of strict attention to it; if it be the investigation of a principle in physics, only well-directed attention to the factors involved can make for results; similarly, if it be study of a poem, or a prose selection, or a grammatical principle, or an epoch in history, sustained and concentrated attention upon that thing is the prime condition of mastery.

All this, of course, does not mean that once the learner has set out upon a topic of investigation there is to be no turning back and no withdrawal of attention. Such an implication would be absurd. The scientific man who is striving with all his powers to push out the frontiers of knowledge must have surcease from his labors anon in order that he may rid himself of fatigue and attack his problems refreshed and stimulated. So, in a parallel sense the child-learner, who is engaged in following the man of science afar off, cannot be expected to hold his attention long to a line of inquiry. Rest periods, recess periods, even distractions, are essential: the sin lies not in turning aside from the pursuit of wisdom, or in being turned aside; it lies rather in the attitude of mind which embraces every opportunity, legitimate or otherwise, to neglect the present task and attend to side issues.

The child mind is naturally immature. Its background of understanding is limited; its appreciation of the meanings and values to be derived from study is correspondingly slight. If the educational appeal that is brought to the mind in this state of undevelopment comes through an ill-adapted method of teaching or, worse still, through a teacher who has failed herself to grasp the full significance of the factors underlying thoughtful attention, small wonder that the pupil finds the attentive state decidedly distasteful and onerous, and seeks release in attention to more appealing stimuli! Teachers who are embarrassed and impeded by inattentive pupils that are extravagantly wasteful of time have often none to thank but themselves for the development of this unfortunate state of mind in their children. At its best, the child mind requires clever motivation and much refinement and variety of method, if it is to work thoughtfully and economically; at its worst, it will profit little if any from less clever motivation and excellence of method. Teachers who are to make good with the child mind must take these facts into account. They need to be masters of their own concentrative powers, and at the same time sufficiently familiar with the psychological factors underlying the attentive state to be able to initiate and direct it economically and efficiently in others.

Attention classified according to the feeling-attitude of the one attending: 1. Forced attention. Very many of the tasks which confront both children and adults are of such a nature that distinct effort is necessary in order to attend to them. Among such are included uninteresting or unattractive duties which are either imposed by others, or else are prescribed by one's own sense of obligation, and possess no attractiveness for him. Take for example the case of the boy who is refused permission to spend an afternoon with his chum, in order that the lawn may be trimmed, or the potatoes hoed. Another's will is dictating what he shall do, and he finds the repression of his own extremely distasteful. Or suppose, while knowing that no one will censure him if he spends the afternoon as he pleases, the boy decides that his duty is to remain at home and help his father. Here again the probabilities are that his heart will be far away from the work in which he engages. It is his own will that is dictating in this instance, but the unattractiveness of the task is none the less keenly felt than in the case where the will of another is superimposed. To attention thus given to tasks which are distasteful many psychologists have given the name, *forced attention*.[1] As a type, forced attention cannot be given until the person attending has reached a plane of intellectual evolution where the factor of choice between two lines of action enters in. To deny one's self the certain pleasure of passing the afternoon on the ball field or in the woods with one's fellows, and to choose deliberately to spend it in hard or at least uninteresting work, is in itself evidence of the achievement of a certain spiritual mastery of one's self.

---

[1] Terminology is often found to be somewhat at variance among writers in the general field of psychology. Thus *forced attention*, as described here, is synonymous with the *active* or *voluntary* attention described by other authors, following James.

Forced attention is, then, the expression of an act of will. By shutting out or refusing to heed this thought-group we are able to concentrate upon that, innately unattractive though it may be. The affective state of unpleasantness is the logical emotional accompaniment of attention of this sort. Neurone groups that are in readiness to discharge are checked, and others not in a state of readiness are called upon to function. Whenever this interposition of the will breaks in upon the nerve 'set' and compels a different neurone adjustment there is correlated an affective reaction of distinct annoyance depending in degree upon the profoundness of the neural conflict.

2. **Free attention.** At the other extreme of human experience are those situations which are attractive in themselves, and to which in consequence it is very easy indeed to pay attention. There is no neural resistance offered to the discharge of neurones that are 'set' for discharge. To the attending state under such conditions psychologists have given the name *free attention*,[1] as antonymic to forced attention. In situations attended to freely there is little occasion for the use of the will. The process in itself is interesting and satisfying, and attention to it is spontaneous and urgent. Now this spontaneity may come either because the situation makes such immediate and insuperable appeal to a sense-organ that attention is drawn involuntarily to it, as in the case of a deafening explosion or a sharp flash of lightning; or because the situation presents to the one attending an interesting point of contact or possibility of self-expression, as in the case of the boy flying his kite or the inventor working at his idea.

Some psychologists — notably Angell — find it helpful to confine the use of the term 'involuntary attention' to situations of the first sort, i.e., where the uniqueness or intensity of the stimulus is such that attention to it is compelled, and suggest as a descriptive term for situations of the second sort, i.e., where the person attending has a personal interest to satisfy, the term 'non-voluntary,' or 'unvoluntary,' or 'spontaneous' attention. Inasmuch, however, as involuntary attention as resulting from the intensity or uniqueness of the stimulus plays little part in the schoolroom, we shall in this volume, unless otherwise noted, employ the term 'involuntary attention' in its broader significance, including all attentive states that are embraced without the interposition of the will.

---

[1] The terminology here again is somewhat at variance. James uses the term *involuntary* or *passive* in this sense.

Free and forced attention illustrated. Perhaps the best general illustration of free attention is found in the play situation. The normal, healthy child needs no dictation of his will power to lead him to engage in a good game of tag, or ball, or prisoner's base, or indeed any other kind of social sport. The play situation, whenever and wherever encountered, possesses attractiveness and delight, and the most profound concentration possible for any one is fixed every day by children at play upon the flight of an arrow, or the reaching of a goal, or the curve of a ball, or the fall of a jackstone, or the roll of a marble.

Similarly, the best general illustration of forced attention is to be found in the work situation when the nature of the work is distasteful or severe, or unadapted to the individual engaged in it. Consider, by way of illustration, the following paragraph[1] descriptive of the nature of the work on the open hearth of a gigantic steel plant. It is a pen picture, done by a novice.

> I was conscious first of the blaring mouths of furnaces. There were five of them, and men with shovels in line, marching within a yard, hurling white gravel down red throats. Two of the men were stripped, and their backs were shiny in the red flare. . . . The mill noises broke on me: a moan and rattle of cranes overhead — fifty-ton ones — the jarring of the trainloads of charge-boxes, and minor sounds like chains jangling on being dropped, or gravel swishing out of a box. . . . I walked with excessive firmness, and felt my personality contracting itself into the mere sense of sight

---

[1] *The Atlantic Monthly*, May, June, 1922.

[illegible] – [illegible]
[illegible] – [illegible]
[illegible]

> and sound. . . . The heat was bad at times: 120 and 130 degrees. . . . It was like constantly sticking your head into the fireplace. . . . The mouth of the furnace gapes its widest, and you must hug close in order to get the dolomite across. Every man has deeply smoked glasses on his nose when he faces the furnace. He's got to stare down her throat to watch where the dolomite lands. . . . Throw your left arm high at the end of your arc, and in front of your face; it will cut the heat an instant. . . . The first and second helpers stagger up (after the "cooking") with bags containing fine anthracite, and drop them into the mess. These have a most damning effect. The flames hit the roof of the pit, and sway and curl angrily along the frail platform on which you stand. . . I looked at the men again. Most of them were hurrying; their faces carried yesterday's fatigue and last year's. Most of them made me think strongly of a man holding himself from falling over a cliff, with fingers that paralyzed slowly. . . . They held their baskets (at lunch time) on their laps, or put them on the floor between their legs. Six or eight were asleep. The rest sat quiet, with legs and neck loose, eyes open, steady, dull, fixed upon nothing.

Value of forced attention. It is not to be concluded, however, that all work, or even work in general, is accomplished under stress of forced attention. It is true, the whip hand of necessity is ordinarily held like the sword of Damocles over the worker, but that dim awareness of the ultimates ought not to remove from toil all the pleasure, interest, and satisfaction that inhere in it. It is probably true of most workers that a considerable amount of voluntary attention has to be given in the initial stages of learning any process. Temporary failures and discouragements are certain to come, and often only a determination to win out at all costs will save the day. Thus, the engineering student who detests the study of modern languages but who finds it required in his course may, by sheer force of will, overcome his antipathies after the first few weeks and settle down to an actual toleration of and even grim enjoyment of the study of languages.

After all, our best work is done under stress of interest rather than will, and hence to entertain the idea that one's work is drudgery cannot but prove disastrous, both in quality of results and in serenity and equanimity of mind. The worker at any trade, whether it be studying a lesson, or operating a machine, or laying a floor, or keeping a ledger, needs, in the interests of his own peace of mind, to be clever in extracting from the day's work a certain amount of real satisfaction. It is obvious of course that forced attention must be given at certain times to any process, and it is well that such is the case. It often happens, however, that as one gets adjusted to a type of work which at the outset was unpleasant and required the devoting of forced attention, he finds less of the disagreeable in it, and may end by becoming actually interested in it. Again, some persons will find wholly distasteful a kind of work which others may enjoy. In either case, we shall probably always find that at stages in the day's work where monotonous repetition of movement is required, or when fatigue products begin to accumulate within the neuro-muscular mechanism, forced attention must be summoned to drive us forward; and, on the other hand, at stages where there is an element of novelty entering, or where challenging problems are encountered, or where the fruits of toil are about to be brought forth as finished products of which we may be proud, a condition of free attention will intervene to buoy us up and entice us forward.

Only free attention brings worth-while results. We should not get the notion that wherever the nature of the task in hand is such that the mind attends to it freely and spontaneously there is no element of work in it. Such is by no means the case. Things are not necessarily easy when free attention is present. It is probably true that the great inventions and discoveries made by man have been the product of long-continued study, not under the lash of the will, but rather under the energizing influence of an interest in a process and a thirst to achieve, to pour out one's personality into a great problem or a great idea.

Forced attention throughout the long years of investigation and research would not only have made drudgery of the work but would necessarily have limited and dwarfed the achievement. Free attention, coming in to impel the genius anon, raised his work from the low plane of drudgery and made it essentially a thing of fascination. Disappointments and failures and handicaps and disparagements came, and the steady urge of will was often a needed ally in bridging over the low, swampy lands of slow progress and ebbing conviction; but, once bridged by an insuperable will, they no longer held the power to discourage, and a returning confidence was attended by a refreshing in-surge of interest and so of free attention. Thus through alternating sloughs of despond and palaces beautiful the way of true achievement has always led into the celestial city.

Evolution of attention in the child. The infant is almost absolutely at the mercy of external stimuli. His background is too limited to afford him any inclination to select voluntarily which of them he shall attend to. The attention which he first gives to the toy, the dog, or the carpet is therefore free attention of the involuntary type. Even then his concentration is very superficial, and the slightest noticeable change in the arrangement or appeal of the external world will summon his fickle stare for the moment. As he grows a bit older and objects begin to have distinct meanings for him his eye is caught less surely by intense or unique stimuli — although of course his senses are always open to such involuntary appeals — and he lavishes his deepening attention more definitely upon such objects or situations as possess interest and attractiveness for him. He becomes the free, spontaneous attender. Throughout childhood, in the large, this is the sort of attention which is characteristic. Whatever holds the child's attention must win it through the spontaneous appeal which it offers. He may tire himself out at the playground, or shout himself hoarse across the alley or the fields, or suffer the extremes of fatigue and even pain — it matters not: his attention is freely and consumingly given to whatever brings pleasure, or is in any sense connected with a consciousness of growing power and mastery.

Early in childhood, however, parents and grown-ups in general are constantly impressing upon the child's mind some rather definite notions of duty and obligation. Life is not all play; there are lessons to be learned, errands to be run, little helps in this and in that to be given, small sacrifices to be made. The child is brought face to face with the necessity of setting aside his own immediate interests and inclinations and considering those of other individuals. He is learning to submerge his own will in the will of others; in short, he is making a beginning of the practice of forcing his attention to the socially approved or required thing. In the schoolroom situation he finds his own interests often rather sharply in conflict with the tasks assigned. On the playground he finds occasional adjustments necessary. At home these conflictions are becoming, if not more numerous, certainly more obvious.

The evolution of the child's attention is, therefore, from the spontaneous to the voluntary. Much of the work of the schoolroom requires attention of the latter sort. It is true, however, that modern notions of teaching incline so to present the subject-matter of the curriculum that a minimum of voluntary and a maximum of spontaneous attention will be vouchsafed by the pupil-learners, the former remaining a constant and ever ready ally of the latter. Ideally, perhaps, we should say that all school work should be attractive to the child. Actually, however, the fact that innumerable situations in life require the force of will to hold the mind to them makes it extremely unwise to bring the child through the school, and up to the point of facing life, under the false impression that only what is pleasing is worthy of attention. In saying that the evolution of the child's attention is from the spontaneous to the voluntary we do not mean to minimize the importance of the former but rather to stress the increasing importance of the latter as the education process proceeds from stage to stage. It is a much more highly developed mind than that represented by the spontaneous, fickle, and objectively aroused attentive states of the child that is able to select wisely and rationally its lines of thought, and to keep to them through difficulties and uncertainties and in the face of diverse and frequently recurring opposing stimuli.

Immediate and derived attention. Besides classifying attention according to whether it is voluntarily or spontaneously given, we may also classify it according to the purpose for which it is given. Under this classification we may distinguish *immediate* and *derived* attention. Suppose a group of boys are playing duck-on-the-rock. Every pair of eyes and every pair of legs and arms are alert and eager. Shouts of delight punctuate successful attempts to knock off the 'duck' and skillful eluding of its animated guardian. It is apparent to any observer that there is in the game something that makes a direct appeal to the players, and that their attention focusses closely upon it without the interposition of will and without any symptoms of *ennui* or fatigue appearing. To such attention, paid to a situation for its own sake, and with no motive save present satisfaction in the process, the term *immediate* has been given.

Suppose, on the other hand, the thing attended to has no direct appeal as a process to the one attending, but is rather concentrated upon because of some remote or ulterior benefit to be enjoyed subsequently. The boy studying a difficult and perhaps wholly uninteresting lesson in order to make a good showing at class time is a case in point. Other illustrations might include such situations as the following: working overtime in order to earn extra money for Christmas; passing through the successive preparatory stages in any business in order one day to be recognized as a master; doing the present unpleasant task in order to receive the approval of another; studying hard in order to be promoted, etc., etc. To such attention, paid to a situation not for its own sake but with an ulterior motive quite apart from present satisfaction in the process, the term *derived* has been given.

Forced attention derived attention. From the very nature of the case, forced or voluntary attention must always be derived. The fact that conscious voluntary effort is being given indicates that the process being followed has no inherent pleasurableness in it, but is rather in the nature of a task to be performed for some sensed but ulterior purpose. Free or spontaneous attention may, however, be either immediate or derived, according as the process attended to is in the one case interesting and satisfying *as a process*, or, in the other case, has been made so by reason of some worth while value which has been attached to it. Obviously, the former of these — immediate free attention — is the ideal state: to do a thing and actually enjoy doing it is perhaps the supreme adjustment of the human mind, making for achievement and economy as well as equanimity of mind.

The fact remains, however, that much of what we do we attack impatiently if not rebelliously because we recognize the present task merely as a stepping-stone, an interposing means, to what the heart longs after. The boy in school, impatient to get through and perhaps go to college, or else out into business, is a typical case. What shall succeed in holding him — resolutely, yes, but also happily in the main — to the long weeks and months of intermediate study and preparation? Apparently but one of two things: his own will power (forced attention) or a reflected interest due to interposition of strong incentives (derived free attention). The former he will need to make frequent use of in any case, but if he is compelled to depend upon will power all the time, or even for the major part of it, his results will be mediocre. Thus, the art of the teacher must step in and supply interesting and compelling settings for the educative process in order that a minimum of forced attention and a maximum of free, thought-derived attention be vouchsafed. This latter problem — the provision of incentives in education — we must discuss a bit more.

Study Text Here—

Incentives. We may think of an incentive as a sort of spiritual stimulant which urges one to direct and maintain his efforts toward a remote end. Thus, the child who aims consciously though somewhat remotely at an adult condition of good health may be stimulated to work toward that distant goal by membership and attendant activities in the school health club, by the daily performance of prescribed health 'chores,' and the awards for faithful work in the nature of badges, buttons, and other insignia. In a sense the whole problem of enlisting the pupil whole-heartedly in any subject of the curriculum is merely the problem of providing the right and proper incentives.

Among those incentives to attentive effort which Professor Bagley classifies [1] as negative, inasmuch as they are designed to secure the child's attention to his work by warning him of unpleasant consequences if he fails or refuses, may be mentioned one that is quite commonly made use of by teachers: fear of punishment. This may involve either scolding and threatening or actual corporal punishment. The former of these — scoldings and threats — are unfortunately employed all too commonly by teachers. Occasional sharp words and rebukes will be of value, but the tendency is for the teacher who resorts to them at all frequently to fall into the 'nagging,' fault-finding attitude that is likely to become chronic. This of course soon spoils any good effect which occasional scoldings might have, and the children are likely to end by ignoring them quite.

Fortunately, while a rare visitation of corporal punishment upon some particularly remiss pupil has undeniable justification, common resort to physical force as a means of compelling conformity is no longer found. Nor is it so pertinaciously administered by those who practice it as by that Haberle, schoolmaster of Germany, who administered,[2] during his fifty-seven years in the schoolroom:

-Spiritual. Applied to that inner force that is [illegible]

Intrinsic ~~of~~ Incentive. One for present pleasure-

Extrinsic ~~of~~ Incentive. One of real value in the future-.

---

[1] Bagley, W. C. *Classroom Management*, chapter 11.

[2] Quoted from Richter by G. Stanley Hall, in *Moral Education and Will Training.*

> 911,527 blows with a cane; 124,010 with a rod; 20,989 with a ruler; 136,715 with the hand; 10,295 over the mouth; 7905 boxes on the ears; 1,115,800 snaps on the head; 22,763 *nota benes* with Bible, catechism, hymn book, and grammar; 777 times boys had to kneel on peas; 613 times on triangular blocks of wood; 5001 had to carry a timber mare, and 1701 hold the rod high — the last two being punishments of his own invention. Of the blows with the cane, 800,000 were for Latin vowels, and 76,000 of those with the rod for Bible verses and hymns. He used a scolding vocabulary of over 3000 terms, of which one third were of his own invention.

After all, negative incentives are of limited efficacy, since they depend for their power upon fear rather than hope. Depriving recalcitrant pupils of certain privileges, or sending them to the principal, or suspending them from the school, are other examples of negative incentives which similarly depend upon fear.

Positive incentives, on the other hand, make use of a higher motive in the pupil's mind; namely, the hope of recognition for meritorious effort and application. On the lower levels this recognition may take the form of actual prizes that have in them some intrinsic value which the teacher could ill afford, and which are likely to develop selfish and undemocratic attitudes of mind on the part of the brighter children who presumably stand a chance of receiving them, and equally envious and undemocratic attitudes in those who are less quick in learning (usually memorizing) and so stand little chance. Other positive incentives on the higher levels include immaterial awards, if wisely and judiciously distributed so that each child is recognized sooner or later; granting of special immunities or privileges, if the recipient does not make the association between 'regular school duty' and 'punishment for those who are slow'; exhibition of pupils' work, provided the specimens of the handiwork of all of the pupils can be included, content as well as form exemplified, and written work be not thus over-emphasized at the expense of oral; the awarding of marks or grades; promotions; judicious appeal to the better instinctive tendencies of the children; appeal to pride in one's self, one's school, one's home; etc., etc.

In all of these positive incentives the aim is not to drive children forward through the educative process, but rather to supply them with the ambitions and the ideals that will lead them to take pleasure and pride in their own progress, thus requiring to exercise less and less forced attention in their school work and more and more derived free attention.

Dr. Dewey's plea for genuine principle of interest. If more teachers and schoolmen were imbued with Dr. Dewey's philosophy of the relationship of interest and effort in education, we would not need to concern ourselves very much with the matter of incentives, negative or positive, to sustained activity on the part of pupils.[1] To base our appeal to children on sheer effort (forced attention) or to 'make' objects and ideas interesting and thus compel attention to them is, he says, to mistake the real principle of interest altogether. The genuine principle of interest is the "recognized identity of the fact to be learned or the action proposed with the growing self." Mind, according to this view, is not an isolated unity *in here*, as opposed to matter *out there*. The object or the force or the principle out there, if properly selected, affords the child the opportunity he craves to realize his own impulses and ideals.

Compelled effort, i.e., attention given through the use of the will, results in dissipated and divided energies, the pupil coming soon to make eyes, ears, and even lips conform to the demands of the teacher, the while a good share of his inner devotion is given to matters possessing real interest for him. In a similar way, there is a danger in too much appeal to artificial interest that the child will become so accustomed to excitation of the sense-organs that he will demand more stimulation of the same sort; that periods of over-stimulation will alternate with periods of inertness and apathy; and that children thus dependent upon a

---

[1] Dewey, John. *Interest and Effort in Education,* Part 1.

Interest – [illegible] in experience ? [illegible]

'sugar-coating' will lack all resourcefulness and initiative when left to themselves.

Perhaps the following five points summarize Dr. Dewey's philosophy of interest:

Interest [illegible]

1. There are certain powers within the child.
2. These powers are urgent for development.
3. These powers *must* be given expression if the individual is to develop naturally and normally.
4. The process of the *expression* of these powers is eminently satisfying.
5. The inevitable results of such expression include right attitudes and habits of work.

Camden, Ala, Ruth Hayes

Physical helps and hindrances to attention. But the best of motivation and the profoundest identification of the learner with the task in hand must wait to a considerable degree upon certain physical factors in the general environment, if the finest educational results are to be had. We may refer to these physical factors under two headings: (1) internal, and (2) external.

Internal helps. There are two internal physical conditions of attention, general health of the organism, and normally functioning sense-organs.

1. *General health of the organism.* Of the first of these, general health of the organism, we need say little. It would be superfluous to defend the thesis that a healthfully operating organism is one of the prime conditions of sustained and profound attention. Let the learner be even remotely conscious of a dragging in his body machinery, and at once his efficiency in the learning process is impaired to an amount determined by the extent or the intensity of the organic upsetment. It is by no means an uncommon thing for children to come to school breakfastless in the morning, and to eat foods at noon or night which are ill adapted to the needs of growth and mental work. In consequence large numbers of pupils are in a chronic state of malnutrition, authorities placing the number of seriously undernourished children as high as 10 per cent of the whole

1 [illegible] within Childs interests [illegible] 2. [illegible] purpose for [illegible] 3 [illegible] [illegible] factors

number, with another 10 per cent definitely below the norms for their ages. Much of the retardation in our public schools is undoubtedly due to defective nutrition in the pupils. In some localities the slogan has been adopted: "Feed the child before you try to teach him!" Without raising here the much flaunted issue of 'paternalism,' the fact remains that careful and continued attention, such as is required of pupils who aspire to move creditably or even passably up through the grades, is conditioned to a considerable degree upon a well-nurtured body.

Malnutrition, of course, is only one of several possible hindrances to a general condition of good health of the organism, although it is perhaps correlated more or less positively with all the rest. Other preventives of general good health include defective teeth; infected tonsils and adenoids; diseased glands; constitutional weakness of any organ, notably of the digestive organs; poor assimilative powers; low resistance powers to infection; high susceptibility to colds, with attendant loss of school; poor home environment, especially the lack of comfortable, airy sleeping quarters; superfluity of out-of-school activities, etc. In short, any destructive influence which reacts directly or indirectly upon the general health and elasticity of the organism or upon any part of it, is bound to affect both the inclination and the power to concentrate the mind upon the daily work.

2. *Efficient sense-organs.* The other internal factor conditioning the maximum of attentiveness and application to the school tasks concerns itself with improperly functioning sense-organs, notably the eye and the ear. So self-evident is the relationship between efficient senses and normal success in school work that all progressive school departments now require some kind of periodic examination of these organs by school health officials, or by the teachers themselves, with reports to parent or guardian where any considerable disturbance in these functions is found. Obviously, the child who does not see clearly and sharply

is at a decided disadvantage in seat work and blackboard work. If the defectiveness be considerable he will fall behind his class; if it be relatively slight but uncorrected, his greater effort to do the work required may cause a condition of strain, and may lead to a highly dangerous nervous tension that will affect his application to the work of the schoolroom in a very marked way. So with defective hearing. The hard-of-hearing child is definitely handicapped. Unable to understand the spoken word, and so failing to respond quickly, he is likely to be misjudged by both teacher and class. Often the child of defective hearing is not himself aware of his deficiency, having never heard sharply. The psychological effect of habitual failure to comprehend can hardly be appreciated by one who has never had this handicap. The poor hearer finds attention to the task in hand difficult. Lacking definite purpose and objective in his study, there is little to stimulate him. He may develop the 'inferiority complex' at being compelled to witness day after day successful and commended achievement by others, while his own results are hazy and uncertain. In less extreme cases children who find it difficult to hear without actual effort are compelled to use more energy in the process of attending, and so are more prone to fatigue than normal hearers.

Perhaps the nearest similar situation that persons of normal hearing face is to be found in listening to a poor speaker, whose words can barely be made out. Such a situation is both fatiguing and annoying to the adult listener, with his broader background of interest and understanding. How much more tiring and de-energizing to the pupil listener whose background of interest and understanding is characteristically more limited and restricted!

External helps. Among those external factors which make easier the initiation and continuance of the attentive state may be mentioned optimum temperature and humidity, good lighting, comfortable seating, frequent opportunity for exercise, and absence of unusual distraction.

1. Room temperature and humidity. In the matter of temperature there seems little doubt that our schoolrooms are kept too warm for the best educational results. Experiments have demonstrated[1] conclusively that when the temperature rises to a point higher than 65° F. in mild weather, and 68° F. in extreme weather, there is a falling off in effort and industry. It is no unusual thing, however, to find a schoolroom thermometer reading well above 70° F. Such excessive heat is almost certain to cause a dulling of the intellectual perspicuity and to foster restlessness, fatigue, and inattentiveness.

With excessive heat often goes excessive relative humidity, due to the failure of gravity systems and most mechanical systems of ventilation to keep down the moisture. In steam-heated buildings in particular there is always the likelihood of too much live steam escaping into the rooms. This excess, augmented by the moisture breathed out by two score or more pairs of lungs and evaporated from two score or more bodies, makes it very easy indeed for the amount of relative humidity in the ordinary schoolroom to rise above fifty per cent, which is the optimum percentage of relative humidity for efficient attention and sustained effort.

2. Lighting. Another external condition of effective attention is the proper lighting of the schoolroom. To supply at each desk a sufficient amount of illumination, without cross-lighting or glare, is in itself a considerable problem, and lighting engineers have by no means solved it as yet for the several-room building of two stories. Bothersome shadows, reflected glare in some quarters of the room, and dimness of illumination in others are frequently to be found. Cloudy or dark days, when the major part of the room is in shadow, are particularly distracting to pupils who sit far from the windows. Well-placed electric lights are indispensable for use at such times, as well as in late afternoon in northern regions during the fall and early winter. School authorities who insist upon the very best lighting arrangements known will find their policy the most economical one as judged merely from the standpoint of pupil achievement, not to mention that of conservation of children's eyesight.

---

[1] For an excellent discussion of this topic consult Professor William H. Burnham's article: "The Optimum Temperature for Mental Work"; in *Pedagogical Seminary*, vol. 24, pp. 53–71. (March, 1917.)

3. *Seating.* Comfortable seating is still another condition of effective concentration. A chair so high that the child is unable to rest his feet evenly upon the floor without perceptible pressure under the knee, or so low that the weight of the body is thrown backward on to the thigh joints inevitably leads to cramping, and so to restlessness and scattered attention. So a desk so high that the shoulders must be raised uncomfortably to permit free movement of the arms upon it, or so low that the viscera are constricted and the weight of the upper body is thrown upon the elbows and upper forearms, results in more cramping, and so more restlessness and shifting attention. In the interest of efficient concentration on the part of their occupants, school desks and chairs need to be carefully and faithfully adjusted as often as twice every school year. As in the case of proper lighting, good seating is a matter of economy in pupil achievement alone, not to mention its importance hygienically.

4. *Exercise.* Still another external condition of effective concentration is to be provided through frequent opportunity for physical exercise during the school day. It is true our modern notions of schoolroom procedure permit far greater freedom of movement than was formerly the case. There is need, however, for more definite and vigorous exercise than is incidental to the routine work of the school day. Since time immemorial our lower schools have had a 'recess' period in the middle of the morning, and another in the afternoon, in order that the tedium of three continuous hours of mental application might be broken. Somewhat recently there has grown up the practice, particularly in the lower and intermediate grades, of throwing

By what contrivance is [illegible] by the [illegible]
[illegible]

the windows wide open for a minute or so and permitting pupils to participate in a lively calisthenic exercise several times between lessons, and at intervals throughout the school day. This practice, rightly controlled, is to be commended in schoolrooms generally. Coming as it does after a reasonable period of mental application, it flushes out the lungs, withdraws the blood from the brain and sends it coursing through the tissues with renewed energy, thus more rapidly removing the toxic products of fatigue and making ensuing intellectual application more effective, the assumption being of course that the exercise is to be neither violent nor long continued. Holmes, for example, found[1] that a moderate walk and a four-minute calisthenic exercise were noticeably stimulating to concentration immediately thereafter.

5. *Distraction.* One other external condition of effective attention is absence of unusual distraction. Paradoxical as it may seem, experiments in the laboratory indicate that often best results in attention and learning are achieved under conditions of distraction, the observers tending to throw more energy into keeping in mind the datum to be learned when they are definitely aware of the introduction of a distracting factor by the experimenter. The same observers learning a no-distraction series have been found to make poorer records than in distraction series.

While this is sometimes true of learners working under experimental conditions, it would be absurd to contend that it was true of pupil-learners working under ordinary conditions. Customary activities of the schoolroom, such, for example, as pupils moving about, handling books, etc., come very soon to be non-distractive through habituation to them, but let an unusual situation be introduced and forthwith the degree of attention to the task in hand is profoundly modified. There is some evidence, on the other hand, that while unusual disturbances are detrimental to the attentive state, a certain amount of mild sensory stimulation is essential to the most effective concentration. Dead silence appears unconducive to profound mental application, if for no other reason than that it involves no challenge to the attending mind. The unusual always distracts, whether it be quiet or disturbance.

---

[1] Holmes, M. E. "The Fatigue of a School Hour"; in *The Pedagogical Seminary*, vol. 3. 1895.

Mental attitude of the one attending. Other things being equal, the best results of learning will be achieved by the pupil whose attitude is anticipative, interested in, and favorable toward the task undertaken. An attitude of unfavorableness, fostered by dislike, lack of confidence or interest, or by skepticism, is necessarily reflected in the results achieved by the learner. In the card-sorting experiments performed by students under the writer's direction, it has been invariably the case that those learners who approached the day's trials with a determination to better the score of yesterday, and consequently with a general attitude of physical and mental alertness, have appreciably outdistanced other subjects of similar abilities who entered upon successive sortings either in a frame of mind unsuited, or with a preconceived conviction of spoiling the previous score. The former is alert, profoundly reflective, tensely alive to the situation; the latter, preoccupied, mechanical, lackadaisical. Applied to the schoolroom situation this would mean that the pupil-learner's mental attitude is of prime significance as conditioning the degree of attention given to the task, and the excellence of the results achieved.

Professor Pyle sums up[1] the matter excellently, thus:

> The importance of the attitude of school children is certainly very great. If they are to learn effectively, they should be favorably disposed toward the teacher, toward the school, toward the various school subjects, and toward the specific task or lesson. If the child likes the school, the teacher, and the particular work, fast progress is assured if other factors are favorable. Dislike of the school, the teacher, or the task works against progress. When a favorable attitude on the part of the pupil is secured toward the

---

[1] Pyle, W. H. *The Psychology of Learning*, pp. 59–60.

various aspects of school life, successful learning is assured, as far as the pupil has ability to learn. On the other hand a pupil that has a dislike of the school, the teacher, or the particular work, proceeds under a very great handicap. A year of school is wasted for many a child because of such dislike. One of the teacher's greatest problems and duties is to secure a favorable attitude on the part of those to be taught.

QUESTIONS AND PROBLEMS

1. The significance of 'reaction time.' How is it determined for any individual? Report upon the technique of reaction-time experimenting.
2. Make as full a list of (*a*) positive and (*b*) negative incentives as you are able. Cf. especially References 1 and 2, below.
3. Study carefully Part I of Professor Dewey's *Interest and Effort in Education* (pp. 1–15) and prepare a comprehensive statement of the author's conception of the principle of interest as affecting pupils' attention.

SELECTED REFERENCES

1. Bagley, W. C. *Classroom Management*, chapters 9, 10, 11, and 12.
2. Horne, H. H. *Psychological Principles of Education*, chapter 28.
3. Offner, M., and Whipple, G. M. *Mental Fatigue*, pp. 74–115.
4. Strayer, G. D., and Norsworthy, N. *How to Teach*, chapter 3.

Review [illegible] text.

LESSON 12

INITIAL PHASE OF LEARNING: IMPRESSING THE DATA

2. LEARNING CAPACITY AND FATIGUE

EXPERIMENTS:

23. *Correlation of abilities in school subjects.* Secure the school marks of a class of children in the practice school, preferably over a period of four years. Average all the marks received in language, arithmetic, history, and geography during that time. The process can be simplified by arranging the marks in parallel columns, thus:

Pupil No.	Language	Arithmetic	History	Geography
1	80	76	90	74
	75	82	80	82
	90	74	84	80
	78	80	90	88
	Average			
2				
	Average			
et al				

If the instructor secures the individual record cards beforehand, they can be distributed among the students at the laboratory period and the tabulations made in a few moments. After the several grades have been listed they should be averaged for each subject. From a careful inspection of the results, it will be possible for the students to arrive at fairly definite conclusions as to whether, on the whole, capacity to learn is general or specific. The averages should be preserved carefully in the notebooks for use in Experiment No. 36, in the Appendix, in which instructions will be given for working out mathematically the intercorrelations between grades in the several subjects.

24. *The effect of fatigue on concentration.* For this experiment it will be well to divide the class into two groups, Group A being the practice group, and Group B the control group. The materials necessary include: (1) sheets containing thirty-six multiplication examples in which multiplicand and multiplier both contain six figures, no one of which is below 6; and (2) two sets of sheets containing fifteen nonsense syllables. Both the practice group and the control group are to learn one set of nonsense syllables, keeping careful records of the time required by each individual. Immediately after, the multiplication sheet is to be given to each student in Group A, with instructions to perform the multiplication as accurately but also as rapidly as possible. The control group, while this part of the experiment is going on, may do anything they please so long as it is not fatiguing. At the immediate conclusion of the multiplying, the second series of nonsense syllables is given to both groups, and the time required by each individual to learn it carefully recorded. Tabulate the results of learning the two nonsense series in such a way as to show the residual influence of fatigue caused by the multiplying upon the students in Group A. Each student should write up the experiment, with his own score and conclusions, in his notebook.

? Why?

Learning capacity general rather than specific. In most of our schools certain pupils come very early in the year to have the reputation of 'good' or 'superior,' while certain others are looked upon commonly as 'poor' or 'inferior.' Is it then true that capacity to learn is a general characteristic of an individual, and that the child who is a good pupil in arithmetic is also good in history and English and science? And, on the other hand, is the child who barely passes his arithmetic likely to make but a poor record in the other subjects which he studies? Is the good learner a good learner of everything, and the poor learner a poor learner of everything? In other words, are the brain cells and neural pathways of a given individual pervious alike to all kinds of data, apprehending and retaining each with like consistency, or are they so constituted as to offer less resistance to certain materials than to others?

These questions are of considerable significance to education, for if it can be demonstrated that an individual possesses a general rather than a specific learning capacity it should be the concern of the teacher to discover through careful observation and experimentation exactly what the possibilities of a pupil are, and once having established them, to require that in all subjects of study he do equally good work. Uniformity of ability, if it can be shown to exist, should therefore prevent any noticeable divergence as between standing in this subject and in that. If, on the other hand, it can be demonstrated that each individual possesses specialized learning capacity in each of several departments of study, it must then become the duty of the educator at least to stop talking about bright and dull students in general, and undertake, so far as possible, to determine exactly what the several learning abilities of each individual pupil are.

Some empirical evidence. The testimony of much observation of and experience with large numbers of pupil-learners is ordinarily to the effect that capacity to learn is general, rather than specific. This probability is indicated by the attitude of every one concerned with the educative process. The parent whose child receives a low mark on his record card desires to know why John 'did poorly' this month in this or that subject. John himself admits that he 'fell down' in geography, or reading, or arithmetic; the teacher is displeased and reproachful of John; John's classmates exclaim banteringly over the unwonted low mark. Every one, in short, shows by his attitude that John's abilities in the several school subjects are assumed to be tolerably even, and that some purely extraneous factor has apparently operated to keep John from winning the mark which should be rightfully his in this 'low' subject. His slump is assumed to be temporary and incidental, and the confident expectation in the minds of all concerned is that he will pull himself up next month and receive the customary good mark.

This evenness of school abilities is indicated strikingly by Table II, which presents the tabulation of all the grades received by a division of 25 normal school students during a single quarter. Nine marks were given in each case.

These grades, it will be noted, are fairly uniform for each individual. Students who received one or more A's received no D's, and an aggregate of only 13 C's as against 24 B's. Students who received D's in any subject received no A's, and an aggregate of only 6 B's as against 18 C's. Five students (20 per cent) received B or better in all subjects; eleven students (44 per cent) received B or C in all subjects; six students (24 per cent) received A, B, or C in all subjects; three students (12 per cent) received B, C, or D in all subjects. When we consider the different standards and bases of marking used by the instructors concerned, the evenness and uniformity of the grades awarded each individual become still more striking.

Experimental evidence of general learning capacity. But we do not need to rest content with empirical evidence to the effect that capacity to learn is general rather than specific. Experimental evidence from the laboratory confirms our thesis in no doubtful terms. Terman concluded,[1] from his mental survey of some eighty superior children (having I.Q.'s in most cases of 140 or above), that they were "superior" or "very superior" in 360 out of a total of 461 ratings in school subjects, "average" in 80, and "inferior" or "very inferior" in only 21. The 21 low ratings were distributed among such subjects as music, spelling, manual training, and drawing. No grades were found below "average" in the fundamental subjects of reading, arithmetic, history, and geography.

Pyle reports[2] the interrelation between four different

---

[1] Terman, L. M. *The Intelligence of School Children*, pp. 173 ff.

[2] Pyle, W. H. *The Psychology of Learning*, pp. 159 ff.

TABLE II. SHOWING GRADES RECEIVED BY A CLASS OF TWENTY-FIVE STUDENTS

	GRADE A (90–100)	B (80–89)	C (70–79)	D (below 70)
No. 1.		6	3	
2.		5	4	
3.		5	4	
4.		3	5	1
5.	3	5	1	
6.	2	7		
7.		7	2	
8.		3	6	
9.		6	3	
10.		5	4	
11.		2	6	1
12.	3	4	2	
13.	4	5		
14.		6	3	
15.		5	4	
16.	3	4	2	
17.		4	5	
18.	5	4		
19.	3	3	3	
20.	1	8		
21.		1	7	1
22.		5	4	
23.	3	5	1	
24.	1	4	4	
25.	3	6		

types of learning: motor learning (card sorting and marble sorting), semi-motor learning (substitution experiments), ideational learning (experiments with nonsense syllables), and motor-inhibited learning (mirror writing). The experiments were repeated with several different groups of observers, usually having about 75 to the group. The average learning capacity of each observer for each type of learning was computed, and all the possible correlations were worked out (41 in all). Table III shows the results.

TABLE III. SHOWING THE AVERAGE CORRELATION OF EACH OF FIVE TYPES OF LEARNING WITH OTHER TYPES
(From Pyle)

TYPE OF LEARNING	AVERAGE OF CORRELATIONS
Digit substitution	.594
Alphabet substitution	.547
Nonsense syllables	.441
Card sorting	.496
Marble sorting	.503
Average of all	.516

These results are not only constant and uniform, but they indicate a high positive relationship between the abilities required to learn the different types of material, a raw correlation of .50 or better being generally held to mean a high positive relationship between the data under computation. Pyle suggests that, could such disturbing factors as different manipulative facilities and different affective attitudes, due to different past experience and in no wise related to capacity to learn, have been eliminated, the individual correlations would doubtless have been perfect, i.e., unity (1.0). As it stands, however, this particular experiment seems to have demonstrated that a learner who is quick, slow, or average in motor learning is likely to be correspondingly quick, slow, or average in semi-motor and in more strictly ideational learning.

Starch's study of school grades. In the case of school grades it is often a somewhat unsatisfactory process to attempt to reach any exact conclusion as to the correlation in abilities, owing to the fact that the marks given by one teacher may be awarded on a basis appreciably different from that employed by another teacher in making up her grades. In an endeavor to minimize the effect of inaccuracy in school marks, differences in interest and effort, etc., Starch obtained[1] the marks of 64 pupils who had a continuous record over a period of four years in the fifth, sixth, seventh, and eighth grades of two schools in Madison. Table IV shows the correlations between the marks, fifteen in all.

TABLE IV. SHOWING INTERCORRELATIONS AMONG GRADES RECEIVED BY MADISON CHILDREN

(After Starch)

SUBJECTS	GROUP I (40 pupils)	GROUP II (24 pupils)
Arithmetic and Language	.73	.85
Arithmetic and Geography	.74	.83
Arithmetic and History	.73	—
Arithmetic and Reading	.45	.67
Arithmetic and Spelling	.42	.55
Language and Geography	.86	.85
Language and History	.77	—
Language and Reading	.80	.83
Language and Spelling	.77	.71
Geography and History	.81	—
Geography and Reading	.83	.80
Geography and Spelling	.68	.52
History and Reading	.67	—
History and Spelling	.37	—
Reading and Spelling	.72	.58

The coefficients from Starch's study are considerably higher than many investigators have reported. Thorndike, for example, found[2] correlations much lower, though still definitely positive, as indicated in Table V.

TABLE V. SHOWING CERTAIN CORRELATIONS AMONG GRAMMAR SCHOOL SUBJECTS

(After Thorndike)

English and Mathematics	.39
Geography and Mathematics	.36
English and Geography	.43

---

[1] Starch, D. "Correlations among Abilities in School Studies"; in *Journal of Educational Psychology*, vol. IV, p. 415. 1913.

[2] Thorndike, E. L. *Educational Psychology*, vol. III, chapter 4. 1903.

Starch concludes that the higher coefficients of correlation found among the Madison grades are due to the fact that the data on which they were computed are more accurate than those ordinarily employed, inasmuch as the school grades used were averages of all grades received in a subject over a period of four years. This gives a much more accurate picture of a child's actual central ability in a subject than could be gained by taking any term grade. To demonstrate the fairness of this conclusion, Starch in several instances computed the correlations among marks received for a single year by these same 64 pupils, and found the coefficients to be no higher than those usually quoted; thus, between arithmetic and language the correlation when computed in this way fell to .41 as against .73 and .75 on the four-year basis; arithmetic and history similarly dropped from .73 to .40; while in language and history the coefficient fell from .77 to .53.

3

Correlation of abilities. Commenting upon this same necessity for basing correlations upon extensive rather than immediate performance, Hollingworth says:[1]

> "General ability" seems to have reference to final capacity rather than momentary performance if the correlation is to be high. Give each individual the opportunity to attain his limit of efficiency, his highest level of performance, and when these final limits are reached individuals who excel their fellows in one type of work will also excel in other types of work.

Other studies of the correlation of abilities in the same individual have been made by numerous experimentalists: Betts, between kinds of imagery; Pederson, between ability to perceive through the eye and through the ear; Meumann between span and intensiveness of attention; Burt between the more complex mental functions; Thorndike between speed of learning and excellence of memory; *et al.*

---

[1] Hollingworth, H. L. "Correlation of Abilities as Affected by Practice"; in *Journal of Educational Psychology*, vol. IV, pp. 405 ff. 1913.

Commenting upon the experimental evidence, Thorndike says:[1]

> On the whole, negative correlations between different "efficiencies" or "adaptabilities" or "desirable traits" are surely rare, seem almost never to occur as a result of original mental nature, and require as causes peculiar oppositions of influence upon the two traits from the environment.

Whether two operations requiring similar mental process, but different in content, will correlate highly (as for instance strict attention to one's school work and strict attention to social duties, business, etc.) is, of course, quite another matter, and we shall investigate it in a later lesson on transference of training.[2]

The weight of experimental evidence appears to substantiate the theory that capacity to learn is general, rather than specific, and that a learner who is quick to learn one kind of datum is, other things being equal, quick to learn another kind. Conversely, the slow learner of this is likely to be the slow learner of that; while the moderate learner of this proves often to be a moderate learner of that.

What shall be said, however, of those learners who are conspicuously above or below the average in learning certain specific data? Observer *F*, for example, is found to be virtually tone-deaf; i.e., she is unable to discriminate after considerable practice between pitches as perceptibly different as ten vibrations, while other *S's*, after a similar amount of practice, have a difference limen as low as 0.7 vibration. In logical memory tests, substitution tests, and in tests of general intelligence, however, *F* is found to rank approximately 'average.' Obviously her capacity to learn to discriminate and appreciate musical variations is not only decidedly inferior to that of others, but is notably below her own level in learning other data. So one finds often in classroom or laboratory a learner who, while possessed otherwise of something like ordinary ability in learning, is hopelessly deficient in some specific type of acquisition requiring specialized ability, such as mathematics, art, linguistics, etc.

---

[1] Thorndike, E. L. *Educational Psychology*, vol. III, p. 363.

[2] It should be borne in mind by the student that, while the weight of experimental evidence undeniably points to the proof of the point of view outlined in the foregoing pages, some scientific workers have failed to discover such high positive correlation between capacities as the investigators mentioned.

Two supplementary considerations. The explanation of this seeming exception to the theory that ability to learn is general, rather than specific, is to be found in one of two supplementary considerations. In the first place, certain data to be learned effectively and economically require the possession on the part of the learner not only of good general learning capacity, but in addition a specific ability in mastering a given type of datum. Thus, observer *F*, referred to above, who is not endowed with specialized capacity in tone discrimination, may be contrasted with another observer, *V*, who has been musically inclined since earliest childhood, and who was able in the laboratory to discriminate, almost without practice, tone differences of 0.3 vibrations. So with other kinds of material requiring specific abilities; mathematics, art, and languages. Efficient and masterful learning in these cases is conditioned not only upon a general learning capacity of high order but also, it appears, on the presence in the learner of specific abilities in these several fields of acquisition. Learners of the type of *V* are by nature endowed with conspicuous abilities — it may be in music, or it may be in art, or it may be in something else — which enable them to go far beyond their fellows of like general learning capacity, but of inferior specific talents.

The other supplementary consideration to be taken into account in the explanation of apparent exceptions to the principle that capacity to learn is general rather than specific is the matter of the past experience which a learner has had with a given type of datum. We may infer in general that every mature subject brings to whatever situation confronts him two factors, resultant from his previous experience: (1) knowledge or skill, and (2) mental attitudes. Thus, one pupil brings out of his environment certain bits of information, certain rudiments of organized knowledge, which another pupil lacks, and in consequence of possessing which his rate of learning and progress will be more rapid in some specific line than will those of his mates. Or again, he may have formed certain habits which they have not, and so his speed of learning is more rapid along certain lines than theirs. Child *N*, for example, is acquainted with scores of the best musicians, operas, and folk-songs, etc., by virtue of the fact that there is a phonograph with well-selected records in his home. He has also acquired rather nice notions of tone, and rhythm, and a tolerable appreciation of what is good and enduring in music. As compared with a pupil from such an environment, child *P*, who has never had the opportunity to hear and discriminate, can hardly be expected to make similar progress in the school study of music, although possessed of no less native aptness than child *N*.

Along with knowledge or skill resultant from past experience go attitudes of mind toward certain kinds of situations which are of profound importance in affecting the progress of the learner in subsequent similar situations. One may, for example, because of past failures or difficulties in arithmetic be led to conclude that he can never do well in that subject, and hence not only neglect it but be confirmed in his aversion to it. Getting the idea that a thing cannot be done is usually sufficient to induce an immature learner to refrain from trying, and, if constantly confronted with the obligation of trying, actually to dislike and even abhor it. In the laboratory this is often the case also with mature observers. In general, such attitudes as lack of interest, lack of self-confidence, dislikes or aversions, and anticipation of failure tend markedly to retard the learning process in any specific field. On the other hand, that past experience which has resulted in arousing interest, or has stimulated one's confidence in himself, or has led to the formation of positive likings or attractions and the feeling of success, tends by so much to accelerate the learning process in any specific field. This factor of mental attitude must be taken into account in explaining a learner's progress in any type of learning.

What makes for general learning capacity? As we have indicated in the preceding paragraphs, in most individuals ability to learn appears to be a general characteristic. Let us go a step further and ask this question: How does the person who has marked general learning capacity differ from the one who is conspicuously weak in this respect?

We may at least tentatively answer this query by citing three characteristics of the mental make-up of a learner of high capacity, viz.: (1) a confidently determined will; (2) the power of profound concentration; and (3) ability to perceive relationships. If we contrast the behavior of two subjects, *R* and *W*, during a card-sorting experiment, we shall have an excellent illustration of the significance of these three determining factors. The experimenter's write-ups of the two performances are as follows:

Subject R. After the cards had been sorted and placed in her hands, *R* stood quietly before the boxes waiting for the signal. Her hand was suspended an inch or two above the pack and her head was slightly inclined toward *E*. Her mouth was firm and her whole attitude was one of extreme alertness and readiness. At the signal 'Ready,' a perceptible tenseness and muscular rigidity came into evidence. She inclined her head a trifle more, and the fingers of her right hand rested firmly upon the topmost card. At the 'Go' signal — almost simultaneously with it, so quick was her reaction time — *R* whipped off the card, turning it as she did so to read its number, and shot it into its proper box with the barest trace of hesitation in the locating of it. Subsequently she was occasionally compelled to hesitate longer in locating a box, several times even passing it by with the card and coming back to it a second or so later. Throughout the entire sorting of the fifty cards, however, *R's* bodily tenseness and her mental and muscular alertness were never observed to shift or vary in the slightest, and

Character of [illegible] Agency

1. retentivity 3. Curiosity 5. [illegible]
2. [illegible] 4. Relationship [illegible]

the forty-ninth and fiftieth cards were deposited with the same profound intentness as were the first and second. Several times there were slight disturbances in the laboratory, but *R's* attention was never interfered with: she appeared to be completely and absolutely oblivious to everything in the world save the task which she was performing. There was at all times in evidence what one might describe as a nervous animation or arousement in *R's* bearing, of a sort that would lead one to think that if the experiment were to be prolonged considerably a strong reaction of mental and nervous fatigue must needs set in.

Contrast with this the same experimenter's account of *W's* behavior in card sorting after a similar amount of practice.

Subject W. *W* stood before the boxes awaiting the signal. She had both hands on the pack and stood quietly, but without any perceptible arousement to the task. When the 'Ready!' signal came, she made no other adjustment than to glance hastily at her wrist watch. At the signal 'Go!' there appeared a momentary toning-up of her body and she started off well. After some five or six cards had been deposited in good time *W* began to experience more or less confusion as to location, often passing her hand with a card several times over the proper box before perceiving it. At such times she shook her head and ejaculated, thus diverting for a second her attention from the sorting. More than once her hand seemed to hover for an appreciable space over the box she was seeking, without her being focally aware that it was the box sought until she had paused to compare the two numbers fleetingly. At least once during the process, *W* looked away from the task to observe what her neighbor was doing, but remembered herself almost immediately and resumed her sorting. Throughout the major part of the experiment her body was relaxed and her general attitude was negative and passive, rather than active and positive.

How do subjects R and W differ in learning capacity? Subject *R* is, obviously, a rapid learner of high capacity; subject *W* is a slow learner of mediocre capacity. The former is wholly dominated by her determination to make good in the trial, as indicated by her tenseness and rigidity of body, her general attitude of alertness and animation, and the complete abandon with which she throws herself into the task. She manifests also the power of profound attention to the point of relatively complete oblivion to all irrelevant surroundings. For the time being the whole range of the universe is for *R* confined to the pack of cards and the boxes into which she is distributing them. That *R* is also endowed with capacity to see relationships is indicated by the quotation from her own introspective account of a sorting trial. She says: "... I found myself thinking at the moment when 13 dropped into Box No. 13, '*Now I must remember 13 is extreme right, top row.*' ... When card No. 1 fell into Box No. 1 I said to myself: '*1 is there*, then. That will be easy, for it is the *first box in the second row!* ...'" Thus does the active mind seek always after relationships whereby it may be aided in the process of impressing a datum.

Subject *W*, on the other hand, is by no means actuated by a determined will. She dallies, hesitates, is relaxed, and at times quite negligent. Her will functions only intermittently. Nor is her concentration deep. Fringe ideas creep in easily and drive out active attention to the sorting of the cards. Her universe includes not only the immediate situation but also situations remote from it, as for instance the performance of some one else near by. Her attention lacks the burning intensity of focus which characterizes the high-powered learner. There is nothing in her introspective account which indicates any particular capacity to perceive relationships. When card No. 11 drops into Box No. 11, the incident is closed: No 'location idea' of Box No. 11 is registered. Only sheer mechanical repetitions of sorting after sorting of the cards will ever develop in *W* an association between that particular number on a card and the location of that particular box in the series. Hers is the sluggish, slow-plodding, machine-like mind that proceeds but haltingly and can rarely soar.

Conditioning factors in learning. In summary, then, it appears that one's general capacity to learn is conditioned

371

upon at least three factors; viz: (1) his determination and confidence, (2) his ability to shut out of consciousness all matters not immediately related to the situation at hand, and (3) his aptness at discovering significant relationships among the data upon whose mastery he is engaged. Given these three abilities in a high degree, we have the rapid and economical learner; given them in a low degree, we have the slow and uneconomical learner; given them in moderate degree, we have the learner of fair capacity. It appears to make little difference, too, previous experience being equal, upon what sort of data the learner works; his progress in all related types of learning will be tolerably even, since it is conditioned in each case upon the operation of these three identical factors.

Fatigue as a factor in learning. One of the important factors in the learning process is the condition of fatigue or refreshment in which the learner finds himself. It is a well-known item of experience that when one is tired he slows down in his performance, whether the work at which he is engaged is physical or intellectual in its nature. Conversely, when one is rested and refreshed by sleep or relaxation he speeds up and maintains a higher level of performance.

What is fatigue? It will perhaps illuminate our discussion of the relationship of fatigue to the learning process if we first note what fatigue is physiologically. Suppose an individual is engaged in rapid writing over a period of several hours. Aside from partial loss of interest in the task, and the gradual setting in of general *ennui* and weariness due to prolonged attention to it, there develops shortly definite discomfort if not even pain in the hand and forearm. If the writing be prolonged sufficiently there will ensue a phase of fatigue in which it will be practically impossible to write at all. What is the thing that has transpired within the working member? Let us investigate.

It is a fact commonly known to the physiologist that two diametrically different metabolic processes are going on within the tissues of the body at all times: a destroying and a rejuvenating process, the balance between which must be maintained if the organism is to operate harmoniously and economically. The first of these, called *katabolism*, is a tearing down process, incident to the using up of energy in some form or other of nervous or muscular activity. The second, called *anabolism*, is a building up, rejuvenating process incident to the assimilation by the tissues of food elements and oxygen brought to them by the blood stream. Fatigue comes about when the poisons or *toxins* thrown off in the katabolic process are so numerous or so powerful that they cannot be carried away by blood or lymphatics as fast as they are produced. An analogy to this 'backing up' of fatigue toxins in the working organ is found in the accumulation of 'clinkers' in the grate, which represent the waste products of combustion in much the same way that the former represent the waste products of metabolism.

Now when a group of muscles is working it is apparent that more energy is being consumed — and consequently more toxins are being thrown off — than when it is quiescent. The individual who has been writing rapidly, for example, finds his active hand much warmer than his inactive one. The accumulation of this residuum of metabolic toxins is the physiological explanation of fatigue. Exhaustion, or complete neuro-muscular prostration, comes about when by reason of unusual strenuousness of exertion or excessive prolongation of the activity — it may be over years of time without compensating daily recuperation through rest and recreation — these toxins have completely poisoned and paralyzed the whole organism.

Numerous brilliant experiments have demonstrated beyond question the production of these metabolic poisons by an active tissue. Chemically, they are found to be comprised largely of lactic acid and acid potassium phosphate. By injecting them into a fresh muscle, Ranke, a German investigator,[1] was able to induce immediate "loss of contracrelating 2 g the a g.

---

[1] For a brief account in English of the experiments on the nature of fatigue performed by Ranke, Mosso, Verworn, Landois, Weichardt,

tibility and capacity for work" in the fresh muscle also. Mosso was able to confirm this by injecting into a lively dog the blood, highly laden with fatigue, from an exhausted dog.

Measuring fatigue. Methods of measuring fatigue have followed two chief lines: (1) the physiological, and (2) the psychological methods. The former seeks to accomplish its purpose by measuring the amount of decrease in muscular force, it being assumed that fatigue in the muscular system follows laws similar to fatigue in the nervous system. Repeated tests with the dynamometer to measure decrease in the hand grip, and with the ergograph to measure diminution in the lifting and pulling strength of the fingers, illustrate this method of determining fatigue. Inasmuch, however, as feeling, attitude, and other subjective factors cannot be controlled sufficiently, results of measuring fatigue by these processes are no longer deemed dependable. due to [illegible]

The psychological methods undertake to establish laws and principles of fatigue by measuring the mental output of pupils under schoolroom conditions. Earlier experiments along this line tried to get at the problem by sampling the ability of the pupils to do equivalent tasks, such as adding or subtracting lists of two-place numbers, at different hours of the day. More recently, however, a so-called 'method of continuous work' has been employed with somewhat better results. As its name indicates, this type of experimentation proposes to measure fatigue by keeping the subjects engaged upon a particular task, such as continuous counting of letters, committing to memory, addition of numbers, etc., for a prolonged period, noting the increase in error or the decrease in the amount of performance as the influence of fatigue makes itself apparent. As used by Kraepelin, the subject adds vertical columns in a specially prepared notebook for an extended period.

Kraepelin, and other Continental investigators, consult *Mental Fatigue*, by Offner, M., and Whipple, G. M., pp. 9 ff. Cf. also the extensive bibliography on the subject in this reference.

Every five minutes a signal bell rings, whereupon he draws a line under the last digit he has added. In this way it is easy for the experimenter to compute after the practice how many digits have been added in each five-minute period, and so calculate tolerably accurately the incidence and development of fatigue.

Some conclusions significant for education. From the numerous investigations that have been made of fatigue, several conclusions of some significance for education are suggested. In the first place, the younger the child the greater his fatiguability. Hence the importance of shorter lesson periods and more frequent pauses for the primary grades. As age increases the susceptibility is lowered somewhat uniformly up to the period of maturity, although there is good evidence to indicate that it is disuniformly high during puberty. In the second place, from the very fact that the fatigue toxins find their way into the general circulation, it is plain that fatigue which is localized and isolated may very easily and does very naturally spread through the tissues and cause a general condition of fatigue. In the words of Offner and Whipple, "it cannot be supposed that in our complicated and psychophysical organism an activity of appreciable intensity can run its course in any part without thereby affecting the functions of the other parts of the organism, and hence of the whole organism." Isolated fatigue, due to the continuous activity of any particular part of the neuro-muscular mechanism, may exist for a brief period, but gradually the toxins thrown off will permeate the whole body, thus bringing on a general fatigue.

Change in type of activity not necessarily recuperative. It has been contended in some quarters that a change in the type of activity being carried on will decrease the amount of fatigue of the organism and bring refreshment. It appears from the foregoing discussion, however, that since a working organ is constantly throwing off toxic materials into the blood, and as constantly drawing recuperative materials from it, there is a progressively decreasing supply of the latter left at the disposal of other organs. Discontinuing activity in one organ and continuing it in another merely changes the source of consumption of energy and the discharge of waste products, without bringing about recuperation. The cause for this popular mistaken notion that change of work diminishes fatigue is probably the fact that turning from a task at which one has grown tired to a quite different one is agreeable and mentally refreshing. The factors of a fresh interest and a radical change of activity operate to minimize the immediate awareness of fatigue. The refreshment that comes from changing from work of one type to work of another of equal intensity is therefore psychological, rather than physiological.[1]

A third educational inference which we may make from the investigations of fatigue is to the effect that a frequent change from intellectual to physical activity is, if proper precautions are observed, conducive to better performance of the intellectual work subsequently. Holmes, for example, found[2] by means of a test in addition and another in the bisection of lines that a moderate walk and a four-minute calisthenic exercise in the schoolroom stimulated subsequent mental work directly. Strictly speaking, physical performance uses up energy and produces fatigue particles just as does mental work, and hence one might infer that calisthenics in the schoolroom or physical exercise in connection with the school day should tend to decrease rather than increase immediately subsequent ability to do intellectual work. Indirectly, however, recuperation does undeniably come about from brief exercises of this sort, especially when taken in the fresh air. Respiration is deepened, the lungs are flushed out with fresh oxygen, fatigue-products are more hastily eliminated, and there comes about a striking renewal of energy. There is, then, virtue in the practice of throwing the windows wide open for brief periods during the school session and allowing the pupils to indulge in a few moments of snappy calisthenics. Let the room be poorly ventilated or the windows actually closed during the exercise, however, and the fatigue effects from the muscular exertion, not being compensated for by the indirect benefits referred to above, would be forthwith noticeable.

---

[1] It is doubtless true, however, that changing from hard work to a type of performance that is considerably easier and less exacting may actually bring about recuperation. In such circumstance the amount of fatigue-producing substances is smaller and the demand upon the available supply of nutriment is lesser, while the balance between the reserve supply and the consumption tends, through respiratory action at least, to be in some degree maintained.

[2] Holmes, M. E. "The Fatigue of a School Hour"; in *Pedagogical Seminary,* vol. III, 1895.

④ **"Fatigue-Coefficients" of curricular subjects.** Fourth, it appears that each subject in the curriculum possesses what Offner and Whipple term a specific "fatigue-coefficient." That is to say, certain subjects are known to make greater demands than others upon the learner. Mathematics and memorization exercises, for example, are generally found to be more fatiguing than geography or language. In consequence of this variation in the fatigue-coefficients of various subjects, and of the suspected greater capacity for hard mental work in the forenoon than in the afternoon hours, it is evident that there is such a thing as a *hygiene of program*. It is the practice in most well-administered schools to put the most difficult subjects (i.e., those subjects which from their very nature require more strict application) in the first part of the day, and after a brief 'warming-up' period. Departmental work obviously interferes somewhat with program-building on this basis. It should, however, pending the results of further experimental work, be possible in undepartmentalized schools to have regard for the fatigue-coefficients of studies in arranging the daily program.

Diurnal variations in efficiency. In general, as we have said, the morning hours are probably somewhat better than the afternoon hours, more energy being available in the

I wish you would +

former than in the latter period. It appears also to be the case that the capacity to work rises to its highest point around the middle of the session (i.e., about ten-thirty in the morning, and again about three in the afternoon). It is probably lowest at the beginning of the session (i.e., at nine and at two o'clock). As compared with the high point of the forenoon session there is reason to believe that the high point of the afternoon session is perceptibly lower. Energy for work, in other words, follows a parallel course in both sessions (starting low and increasing up to the middle point), but is on a distinctly lower plane in the afternoon. Fig. 28 illustrates this diurnal variation.

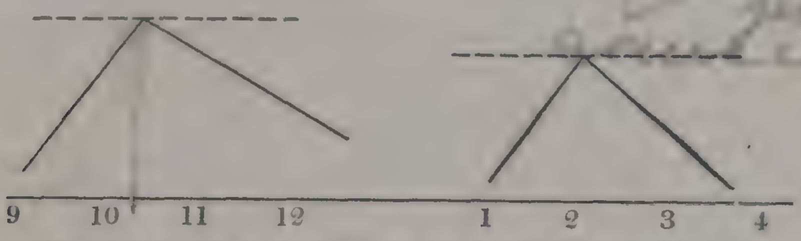


FIGURE 28. SHOWING THE PROBABLE RISE AND FALL OF AVAILABLE ENERGY DURING A SCHOOL DAY

Arbitrarily assigning a fatigue value of 100 to the most fatiguing subjects, Bagley arranges[1] the curricular subjects in the order given below. The table represents a 'composite' of the tables constructed by various investigators in the field.

TABLE VI. RELATIVE FATIGUE VALUE OF SCHOOL STUDIES

Formal gymnastics (unaccompanied by music)	100
Mathematics	100
Foreign languages	90
Formal study of mother tongue (including formal composition, spelling, writing, grammar)	90
History	85

---

[1] Cf. article on "School Management," in *Monroe's Cyclopedia of Education*, vol. v.

Geography	80
Nature Study	80
Drawing	60
Singing	40

Other conclusions from the experimental work upon fatigue have been reached in various quarters.[1] Among the more significant for education are the following: lesson periods should be very short in the primary grades, not longer in most cases than fifteen or twenty minutes, but may become progressively longer in the intermediate and grammar grades; five hours a day for formal school work would seem to be a wise standard, and for five days in the week; home work should be reduced to a minimum in the lower schools; short pauses, with free play in the open air, should be interspersed generously throughout the school day; such pauses should increase in frequency and length as the day advances; the noon intermission should be prolonged sufficiently for the digestive process to be well advanced before the renewal of study; adequate sleep[2] is the best protection the organism has against the inroads of fatigue, from nine to eleven hours being needed by the school child continuously for normal health and growth; hard and easy subjects may profitably be alternated in the daily program; the method of instruction employed by the teacher is a marked factor in the fatiguability of the learner.

Of these conclusions we are fairly sure. Owing to the considerable individual differences between learners, however, and the large number of other factors that enter into the economical adjustment of the organism to the work upon which it is engaged, we shall be obliged to await the outcome of further and more exhaustive study of the whole problem before we can reduce the matter of fatigue and fatiguability to any more scientific exactitude.

---

[1] For a good summary of the pedagogical aspects of fatigue, cf. the article on "Fatigue" in *Monroe's Cyclopedia of Education*, vol. II.

[2] Cf. "The Sleep of School Children, etc." by Terman, L. M., and Hocking, A.; in *Journal of Educational Psychology*, vol. IV, pp. 138, 199, and 269. 1913. Also in Terman's *Hygiene of the School Child*, chap. 20

QUESTIONS AND PROBLEMS

1. Presence or absence in various individuals of specific abilities in such subjects as drawing and music. Consult if possible a special teacher of one or both of these subjects, and question her as to her experience with individual learners.
2. Individual differences in learning aptness due to environmental limitations and opportunities.
3. Construction of a well-arranged program of studies for an elementary school.
4. Experiments that have been made into the nature of fatigue toxins.
5. Diurnal variations in your own efficiency in performing mental tasks, such as adding columns of figures, committing selections to memory, learning nonsense syllables, etc.

Interest is that [illegible] state of attention.

LESSON 13

INITIAL PHASE OF LEARNING: IMPRESSING THE DATA

3. The Psychology of Attention

Interest = Mind set
(whole hearted endeavor)
∴ Interest = conditions favorable to learning.

Experiments:

25. *Concrete versus abstract materials.* *E* should prepare, previous to the laboratory period, three lists of one-syllable words, ten words to the list; thus: book, smoke, bridge, chalk, sky, tray, clock, ice, fern, hook. *E* should also prepare three groups of small objects, ten objects to the group; thus: a key, a pin, a button, a paper-clip, a ruler, a piece of chalk, a knife, a stamp, a blotter, an envelope. *E* now determines *S's* memory for words by exposing each of the words in the first list, one at a time, and instructing *S* to write down immediately after the exposure of the first ten as many of them as he can recall. Similarly, lists 2 and 3 are given, *E* averaging the number recalled by *S* in the three trials. This furnishes us a tolerably accurate measure of *S's* immediate rote memory for words.

E next exposes each of the ten objects in the three groups, one at a time, instructing *S* to write down immediately after each group the names of as many of the objects as he can recall. By averaging the three we may obtain a tolerably accurate measure of *S's* memory for objects. Correlate the two average scores thus obtained from the two parts of the experiment. *S* should write up his introspection in his notebook. Let *E* and *S* change places, new lists of words and groups of objects being prepared by the latter in order that *E's* memory for concrete objects may be similarly compared with his memory for abstract materials.

If there is time available, lists of abstract words may be prepared and *S's* memory for them compared with his memory for concrete words; thus: ire, faith, pride, love, fear, life, scorn, oath, skill, quiet.

26. *Meaningful versus nonsense materials.* *E* prepares beforehand two or more lists of ten nonsense syllables each, and an equal number of lists of meaningful but isolated words, ten words to the list; thus: (*a*) vik, diz, lek, tep, zet, faq, wap, loq, roz, lub; and (*b*) can, hog, ink, stool, pet, head, rose, watch, rib, post. The lists of

nonsense syllables are exposed as in the preceding experiment, one by one, and *S* is instructed to write down as many of the syllables as he can recall after each group of ten. Average the two (or more, if more than two lists are provided), and record the average as an index of *S's* immediate memory for nonsense syllables. Expose the sense words in the same way, and average the results for an index of *S's* immediate memory for concrete sense words. Compare the results. *S* should write up in his notebook immediately his introspection and a discussion of the significance of this experiment for educational purposes. *S* next becomes the experimenter, and a similar procedure is followed out by *E*.

Tests of learning capacity. As we have already seen, there are marked differences in learning capacity to be found between individuals. These differences exist not only in the psychological laboratory, but are found in every schoolroom in the land. Some children are slow learners; some are fast; some mediocre: hardly two have identical abilities in this respect. The teacher comes very soon to know, with reasonable certainty, in what classification a given child falls. If he dallies with his lessons, or if he requires a longer time to achieve a given result than some other child he is adjudged a slow learner; if, on the other hand, he gets results sooner than the others he is adjudged a rapid learner. And so on for all the intervening types.

Recent experimentation has placed in the hands of the teacher a valuable supplementary aid in determining the learning capacities of her children in the form of the so-called learning tests. At best her judgment of the learning abilities of her pupils as determined by watching them study and noting the slowness, moderateness, or rapidity with which they interpret new subject-matter is largely empirical, and fails to take into account several important factors, such for example as differences of interest, previous training, previous school success or failure, etc. The learning test eliminates such complicating factors as these, and affords the teacher an opportunity to get rather definite data upon the relative bare learning abilities of her pupils.

It is often desirable for a teacher to know fairly definitely what the learning capacities of her children are, in order to 'tone up' the class. A considerable number of studies have been made of the actual work done by pupils, as compared with what they were capable of doing, and almost invariably it falls out that those who are the most capable show up poorest, while the slower and less capable show up relatively well. The explanation is, presumably, that the amount of effort being put forth by the former is distinctly less than that put forth by the latter. MacPhail found,[1] for example, that increases in the I.Q. of 409 Providence public school children were accompanied by decreases in the A.Q., and that, on the whole, "the greater the intelligence of the pupil the less is he actually accomplishing in school what one is justified in expecting him to accomplish." He concludes:

> Existing standards of achievement in the elementary school are better suited to the slower pupils than to either the normal or the superior pupils. Accordingly, the normal (average) and especially the superior children are not working up to their capacity, and under such conditions can only be expected to contract habits that are not conducive to studiousness and industry. In actual practice, it was found that 60 per cent of the four hundred odd pupils were retarded 17.9 months each, on the average, with respect to mental age. In other words, the mental age of 60 per cént of the children was one year and a half beyond the average mental age of the grade in which each pupil was found to be classified. In terms of intelligence these pupils were capable of doing work beyond what they were being asked to do. Likewise, in terms of the school subjects tested, 33 per cent of the pupils were found to be classified nearly one year (10.9 months), on the average, below where one would expect to find them. In other words, their pedagogical age exceeded by nearly a year the average pedagogical age of the grade in which each was found respectively.

The difficulty appears to be that practical educationists have not yet awakened to the fact that each pupil is possessed of a certain fairly definite capacity to do school work. Consequently, while the theoretical educationist has been for some time insisting upon the importance of finding out the capacity of each pupil, teachers have been perforce trying to adapt the same educational methods to extremely heterogeneous groups of children and striving to get something like uniform results in all cases. The result has been that the slower child has been speeded up, while the more capable one, far from being pushed to the extreme of his ability, has been permitted to slow down. Aim and purpose have been obscure and outcome fortuitous. The only way in which we can hope to redeem ourselves is to set to work to find out means of determining the actual learning capacity of every child, and then to readjust the educative process in such a way as to force him *to the limit of his ability*. Nothing less than this has any justification in the schoolroom.

---

[1] MacPhail, Andrew H. "The Correlation between the I.Q. and the A.Q."; in *School and Society*, vol. XVI, no. 412. 1922.

Going at the educative process scientifically. The first thing for any progressive educational system then to do is to diagnose the learning capacity of every pupil in it, to the end that proper classifications and gradings may be made. In the absence of such a comprehensive program as this any teacher may with reasonable accuracy determine the relative learning capacities of her pupils, and thus be in a position to know at what pace they ought to go up the educative pathway. Society can ill afford to permit its more capable children to dawdle: A.Q. must correspond at all points with I.Q. 'Full steam ahead' must be the determined program of every teacher for every pupil.

There are a considerable number of tests of learning capacity on the market. Probably a combination of at least two will prove the most satisfactory: a substitution test, and a logical memory test. Pyle recommends the employment of two additional ones: card-sorting and nonsense syllables. It is probable, however, that a substitution test and a logical memory test, properly handled, will suffice for the purpose. It is obvious, of course, since learning is associating new data with one another, that any test devised by the teachers may be used as a valid measure of learning capacity, provided the data to be learned have not previously been experienced. The author recommends, however, Pyle's "Symbol-Digit" test and Whipple's "Marble Statue" test,[1] as being easily procurable, inexpensive, and possessing the merit of having been standardized through wide use by teachers and experimentalists.

Administering the tests. The digit-symbol test should be given somewhat as follows. After the nature of the task (which may be referred to as an interesting game) has been explained to the pupils, they should be given a certain number of minutes in which to master the key — say, five for grades above the fifth, and perhaps eight for grades through four and five. During this time they are not to make any of the substitutions called for on the sheet, but are to form as reliable images as possible of the symbols and their respective digits. When this has been done, they should be instructed to turn over the sheet and wait for the starting signal, at which they are to make as many substitutions as they can in one minute. The procedure should be continued, with an interim of thirty seconds between each series, at least for six trials. The score of each pupil will then be indicated by the number of correct substitutions he makes on the sixth and last trial. Care must be exercised by the teacher that every child follows directions absolutely, and that no accidental distractions, such as broken pencils, etc., occur to influence the performance of any individual.

The Whipple test of logical memory is in the nature of an interesting story to be read to the class, after the following preliminary instructions have been given:

> I am going to read you something to see how well you can remember it afterward. You must pay careful attention, as I shall

---

[1] Pyle's test (no. 31027, Pyle's *Manual*) may be secured in quantity at about one cent each from C. H. Stoelting Company, Chicago, Ill. Whipple's test (p. 179, Whipple's *Manual*) may be secured at approximately identical cost from the same source.

> read it but once. As soon as I have finished, take your pencil and write as much of the story as you can remember. If you can remember it in just the words you heard, use those words, but if you can't do that, tell in your own words, as well as you can, what it was that I read you.

The story is arranged in such a way that its one hundred and sixty-six words fall easily into sixty-seven distinct ideas. The score for each pupil is indicated by comparing his reproduction with the divisions of the original text into ideas. A more accurate index of ideational learning capacity may be had by giving one or two additional logical memory tests (e.g., the "Dutch Homestead," and "How Mr. Lincoln Helped the Pig," from Whipple's *Manual*) and averaging the percentages of ideas reproduced in all of them. Thus, if pupil A correctly reproduced eighty per cent of the ideas in the "Marble Statue" test, ninety per cent of those in the "Dutch Homestead" test, and eighty-five per cent of those in "Mr. Lincoln and the Pig," his score would be eighty-five per cent. The results of these tests, combined with those of the digit-symbol test, and with any others given, may be taken as the measure of general learning capacity for a given individual.

Some pedagogic inferences from the psychology of attention

Attention is best aroused when the new datum is related to something definite in the children's lives. It is difficult to attend to the unrelated and the impersonal. Too much of the work of the schoolroom lacks human and individual appeal. The children spend a few minutes in this subject and a few minutes in that, studying them from textbooks or lexicons, striving mechanically to impress certain facts and principles indelibly upon their minds, as though forsooth their brains were wax records which must be subjected to pressure from without in order to retain. Recitations are often merely 'giving-back' exercises, in which the record is caused to rotate and return to the teacher what it has received from the book. What is needed, and what fortunately the wisest teachers are doing and have always done, is to make a point of human contact between the learner and the datum. We have already referred to the necessity for the pupil thus to identify himself with his task in our discussion of motivation. (See Lessons 2 and 3.)

Some lessons obviously lend themselves to this more easily than others. It is doubtful, however, whether in the hands of a skillful teacher most lessons in every subject cannot be so related, and there is certainly good ground for contending that lessons which cannot in some natural way be definitely tied up with the life of the child at some point or other ought not to be taught at all. This thesis could be very easily defended as applying to the curriculum of our elementary schools. If young teachers, early in their experience, would but form the practice of being always on the alert for these points of human contact in the lesson they would be well repaid in the keen interest, the sparkling eyes, and the ready response of their pupils.

A good example of such relation. The following incident, which occurred in an eighth-grade class in history recently, illustrates well the success with which the teacher concerned was able to relate the page to life.

The class were discussing the problems of reconstruction that confronted the North and the South at the termination of the Civil War. The teacher directed the children's attention to a short paragraph in one of their source books (Beard and Bagley's *History of the American People*) in which the following statements were made:

> Millions of farm "hands" who had been bought and sold and who had been absolutely at the beck and call of their masters, were now freemen, at liberty to go where they pleased. This was a strange condition of affairs. It had come suddenly — without warning or preparation. There they stood, poor people, with empty hands and untrained minds, helpless in a world which they did not understand, at a loss which way to turn.

The teacher, unwilling to let this paragraph go by without its full human significance being felt and understood by the children, inquired whether there was any parallel condition to-day. One child — a newcomer to our shores — likened the condition of immigrants newly arrived in our cities to that of the Southern freedmen in 1865, and painted for the class a rather vivid picture of his own father's experiences five years before, and of his own when he entered for the first time an American school.

The pupils were deeply interested. The teacher asked whether they thought the comparison a fair one. At first they were inclined so to consider it, but upon further reflection they questioned whether the experience of the immigrant could be quite as bewildering as that of the negroes after Appomattox. The immigrant had not come from a previous condition of servitude; he was not illiterate; he was not unused to managing for himself and his family; his hands were skilled; he had burning ambition; he was at the threshold of a great adventure; people might be unsympathetic, but they were not bitter toward him; there was plenty of work for him and a good wage for doing it. The negro had none of these advantages. Illustrations of expatriated peoples, like the Arcadians and the oppressed Christian races of the Near East to-day, were cited and examined. The class concluded subsequently that, while closely parallel instances of helplessness and ignorance among large groups of human beings could be cited, there was probably no circumstance in the history of the American people so fraught with possibilities of tragedy to individuals and to government as this of the millions of slaves suddenly admitted into the body politic. For the first time also these learners of history became vividly conscious of the fact that the Emancipation Proclamation, and even the successful termination of the Civil War, were but a small part of the whole problem of the making of America free and beautiful for the black man as well as for the white man. With this background of comprehension of the many problems confronting the Country subsequent to Mr. Lincoln's assassination, they could go on intelligently to a study of the actual process of reconstruction, particularly as it affected the South.

Attention to a changing more easily given than to a static series. Every one knows how hard it is to read a story that has no life or 'go.' The human mind demands activity, change, progress. Ever flowing on and on rapidly itself, it cannot brook external stagnation. Heraclitus, the classic Greek philosopher, was perhaps the first to call attention to the incessant activity which pervades the universe, and because of which one "may not step twice into the same rivers, for other and yet other waters are ever flowing on." Our consciousness is from its very nature also a constantly changing and evolving process which is thus in tune with the universe. Contrast if you will your mental state while your train pauses for a few moments at a quiet station with that which you harbor while the panorama of a countryside unfolds through the car window after the station has been left behind! And why is it that the moving-picture film holds the animated attention of hundreds of pleasure seekers? Or the hard-fought game on diamond or gridiron that of thousands of spectators? Or the incessant stream of passers-by that of every one of us? It is merely because our impatiently surging minds find a parallel condition of flux in the world of sense exceedingly agreeable and satisfying.

If this thirst of the mind after changing, evolving series is so noticeable in the objective world of sense perception, how much more must it be true in the world of ideation, and if the case with the mature adult subject, how much more with the immature, restless, omnivorous mind of the child! "I don't like school: it's dead!" exclaimed a nine-year-old boy recently. Surely a disheartening commentary upon the school which he attended, and yet no doubt warranted, for too often our schools make scant provisions for clothing the dry bones of this subject and of that with warmth and life. Lessons, to be appealing, must 'move' rapidly, else they can hardly be expected to challenge and hold the active minds of the learners. Assignments to be effective must call for *bona-fide* thinking. Methods of instruction must provide satisfying variety and challenging purpose. Attention to a series is possible only so long as the mind is able to discover new things about it. Beyond that point, though the will may be summoned to compel continued attending, it is a dreary and impoverishing task.

The duration of attention. An interesting sidelight is thrown upon this matter by experiments upon the duration of attention. Theoretically, at least, one may attend to a single object or idea as long as he will. Thus, one often says that he has been thinking about this thing or that for a long time. Actually, however, his attention, if it has been given for a considerable period to a single situation, has been darting from one phase of it to another so that, while the situation itself did not change, the viewpoint of the one attending did. The expression 'turning over in the mind' applies excellently to the actual mental process occurring under such conditions, for what we are doing is attending from different angles and in the light of different interpreting ideas.

To illustrate: Suppose I spend a half hour watching the sunset. What I am actually attending to is not the sunset, but rather a changing series of items about the sunset. I note now the central crimson, now the pink surrounding flush, now the billowing clouds tinted by the sun's glow, now the darkening blue of the neighboring sky, now the rosy window panes on the hill, now the narrowing arc of crimson, etc. If I attempt to focus my attention upon any one of these elements in the whole situation I shall find some other element bursting in suddenly upon consciousness and driving it away. Thus do the waves of consciousness surge onward, never content to be becalmed. Similarly, if I attempt to focus my attention on, say, the 'XII' of the clock, I shall find that the image 'XII' remains undisputed possessor of my consciousness for only two or three seconds at most.

Is it to be marveled at that children who have been set at a school task which arouses in their minds no associations, which has little or no meaning for them, which suggests no intelligible lines of approach, should find their minds going a-wool-combing? They must attend to something, and if the particular task assigned fails to challenge and rivet their thoughts, there can be no alternative: they seek fixation elsewhere. As James remarks: [1]

> Only in pathological states will a fixed and ever monotonously recurring idea possess the mind. The *conditio sine qua non* of sustained attention to a given topic of thought is that we should roll it over and over incessantly and consider different aspects and relations in turn.

Attention more easily given to meaningful than obscure materials. It has been a common fault of very much of the teaching of the ordinary curricular subjects that the ideas resulting in the pupils' minds have been extremely hazy and unreliable. Particularly is this the case with subjects like history, grammar, and hygiene. Children are often lost in a maze of words and phrases whose meanings are obscure and uncertain. They have no clear knowledge of the actual significance of the things they are studying. During the learning process, instead of establishing dependable concepts, they juggle with unknown and unexplained symbols. The only recourse is to attempt to impress these by a process of rote memorization. In the memorial process, operating a few days or a few weeks later in the examination, these symbols are often most bewilderingly shuffled. It could hardly be otherwise.

Teachers should pause often to assure themselves that the materials of the educative process are being thoroughly understood as they are presented. Thorough final assimilation depends upon nothing else than thorough initial comprehension. The marked individual differences of children in ability to understand and interpret these materials must be taken into account, and definite effort be made to hold the slowest and weakest in line. Not infrequently a teacher is very much chagrined and discouraged upon making the discovery, through written examinations or other exercises, that her pupils have but vague and confused notions of certain matters which she supposed had been not only well taught but thoroughly understood. In such circumstance she must go back to the difficulty and smooth it out. It would have been far more economical of time, as well as more satisfactory in results, to have anticipated such disappointing *dénouements* by seeing to it that there was no obscurity or haziness of meaning attaching to the materials at the time they were being studied. Not only this, but as the heading of this section indicates, it is more easy and natural for one to attend to situations that are comprehensible than to those which are meaningless or obscure.

---

[1] James, Wm. *Psychology; Briefer Course*, p. 227.

Attention to a novel series more easily given than to a familiar one. Life is kept from becoming monotonous and dull by presenting always to us something new and refreshing and challenging. One's favorite book, for example, he may read a score of times, and yet each time find something fresh and delightful in it that he had missed before. So with our intimate friends and associates: there are always some hitherto undiscovered heights or depths in their personalities which charm us and give us pleasure. Familiar scenes, roads, and paths we have traveled often are in a sense ever new and enticing. Even our daily round of work often presents to us new situations, new possibilities, if we are only keen enough and clever enough to perceive and appreciate them. It is this tinging of the old and the familiar with the new and unexperienced that keeps our spirit young and our minds alert.

Pedagogically speaking, whatever situation is to be brought educationally before the learner must be possessed of these same inherent possibilities. In the truest sense, no situation may be said to be fraught with educative potentialities worthy the attention of the learner which does not suggest to him many radiating lines of search, each one of which is challenging and some of which he is intellectually inclined to undertake. Under the direction of a skillful teacher a well-chosen educative situation or problem unfolds new meanings and suggests new procedures hour by hour and day by day. Textbooks and sources cease to be merely printed pages, but become alive with new meaning and suggestiveness. Lessons which otherwise might reduce themselves to the unattractive level of the monotonous and the uninteresting become fraught with refreshening possibilities. Assignments, instead of awakening little zest in the minds of the learners, may be made to stir their slumbering spirits and galvanize their dormant wills into determined and eager activity. A problem in mensuration, or a page in history, or a principle in geometry, or an experiment in elementary science, or a lesson in civics may and should be but the familiar starting-point of a very fascinating journey into the great universe of man or of physical matter.

Variety in teaching. To the achievement of this end, variety in teaching method and multiplicity of sources, devices, and materials will be essential, for surely the one-method teacher cannot inject variety into the educative process, and equally certain is it that little novelty attaches to perennial memorization and reciting from a textbook! There must be quest for sources, group or team investigations, field trips, sand tables, product maps, school exhibits and museums, experiments, projects, demonstrations, debates and discussions, criticisms, scrap books and diaries, pupil teaching, chart and graph making, and all the other activities which successful teachers have developed or are developing to add stimulating variety to the work of the schoolroom.

The young teacher needs to beware in this connection the disparagement which the older teacher who has not kept herself young and growing is likely to cast upon the present-day emphasis placed upon variety and interest in the educative process. There is no reason to suppose, as many of its products would have us believe, that the older school got uniformly better — or even equally good — results than the 'modern' school. Lovers of the past do not tell us of the failures and the disgruntled pupils of their day who got next to nothing from the school, but they point only with conscious pride to themselves. Obviously, the best pupils will thrive — relatively speaking — under any system; but the poorer must be fed with milk instead of meat. The school of to-day must teach vastly more pupils, and adapt itself to a far more heterogeneous group, than the school of yesterday was called upon to do. Not only is this true, but the range of subjects required to be studied is much more extensive than was the case in the days when 'school' meant 'the three R's.' To get any results at all from education thus spread out thin the modern teacher must indeed be a master of her art. There can be in our day no slow, leisurely process of imbibing wisdom from a few well-thumbed books. The schools must be at white heat, and go at a record pace. Hence the importance, or rather the absolute indispensableness, of many methods and a multiplicity of means and routes wherewith to achieve the results which society has set. A poor figure, indeed, your typical teacher of two or three generations ago would cut in a twentieth-century schoolroom, confronted with a program of a score of subjects to be taught, and a room filled with forty or more highly graded learners. Even the best teachers of the long ago would find steel worthy of their metal in such a situation.

Attention more easily given when one knows the goal. It appears to be the case that the best results of learning accrue when the learner knows definitely the goal to be reached as a result of his practice. In pedagogical terms this means merely that hazy and indefinite ideas in the pupils' minds as to the results to be achieved by their study operate to dull their interest in and mar their concentration upon the process. Witness, for example, the pupil 'getting' a lesson in history in the conventional manner of rote impression, or working upon arithmetic problems that obviously possess no relationships with life, or memorizing the circuit traversed by the blood through the body! The only clearly defined goal he can have is the questionable one of reciting better than some one else, or the pernicious one of getting done with it all as soon as possible. This lack of identification of the educative content with life and the recognized things of life is disastrous to sustained attention upon and energizing interest in school work.

In contrast with his attitude while he is engaged within the schoolroom in study that suggests no tangible goal, the behavior of the boy outside the schoolroom is strikingly different. It is often as though he were possessed of a dual personality, one of which emerges in the school environment, while the other appears only outside of it. And yet after all the difference is largely due to the presence or absence of a recognized goal. Building a sled or pitching a ball requires no less energy or faithful perseverance than learning a page of history or physiology. But these activities often get more of both than the latter, because of the vividness in the minds of the actors of the results to be achieved. It is obvious of course that manual activities of this sort lead more perceptibly and immediately to results that the performer can comprehend than do intellectual activities. The fact remains, however, that many a lesson set in the schoolroom points, so far as the child can understand, to a blind alley that is as dark as it is blind. Great effort must therefore be exerted by the teacher to make the educational goal appear a realistic and attainable one to the learner. In the event that the goal is a very remote one, lying, perhaps, some years in the distance, the teacher's skill and sympathy enable her to step in and set numerous intermediate goals which will win and hold the effort of the learners from day to day.

To this end, it is highly important that lessons be assigned with definite and clear objective in the lower grades; and in upper grades, where problems are undertaken that require some days or weeks to investigate, that the nature of the topic be clearly understood at the outset by each participant. Much of the indefiniteness of purpose and confusion and dissipation of mental energy commonly observable in the schoolroom will happily disappear when teachers realize, in no uncertain terms, the importance of the learner's awareness of a definite and an achievable goal in all his work.

Attention more easily given if one has a plan or formula. Of equal importance with a clear aim or goal to be achieved in the educative process is it that the learner have a plan or formula by which to guide himself as he progresses toward the goal. The great work of the world has not been done haphazard and by guesswork, but rather in accordance with an orderly and systematic (i.e., *planned*) procedure. The railway right of way laid out across the hills and prairies, the sky-scraper towering out over the city, the well-ordered human life rising in grandeur above the limitations of humble beginnings — all these are but the results achieved by some one building to a plan and toward a goal. On the other hand, the colossal failures of the world — be they coldly material or warmly human — are ordinarily traceable to the lack of one or the other of these twain: a worthy goal or a workable plan by which to achieve it.

The blue-prints of construction are no different essentially from blue-prints of a history project, or a geography project, or a language or arithmetic or drawing project. Lesson learning in its best form is lesson building toward an agreed upon and recognizable goal, and in accordance with a careful plan. Teachers have in mind this principle when before teaching a lesson they determine upon a reasonable goal, or aim, and draw up a definite formula, or lesson plan, by which to be guided in bringing their class to the set goal. The learner himself requires a plan quite as much in his study. What source books shall I find of probable value?

Where shall I procure them? Under what caption shall I search? What person or persons might I interview profitably? What sources other than books would I do well to investigate? When shall I do the work? If several others are working with me, how can we distribute the work to the best advantage? What form is the result of my inquiry to take? These and other questions should be definitely considered by the pupil in connection with every important assignment, to the end that, knowing thoroughly his goal and the ways and means of achieving it, he may proceed smoothly and confidently with his investigation, thus favoring the initiation of interested and spontaneous attention.

Attention the basal factor in habit-forming and knowledge-building. As we have previously seen, there are two goals of learning: the forming of habits, and the securing of information or knowledge. Neither of these ends of the educative process can be achieved apart from constantly recurring states of attention. Every year the author asks young teachers in training, as a means of discovering for themselves something of the real psychology of habit, to determine individually upon some habit which they would like to form or break, and then to set out to do accordingly. Many interesting results are reported, but in every case the student finds that she can make no headway until she reaches the point where she becomes *consciously attentive* to the problem. If the habit upon which she is working, for example, is that of improving her posture, she comes after a few days to pay frequent and increasing attention to her posture. When she falls back into her former slack habits she very speedily becomes aware of it, and voluntarily straightens up. By and by she conquers, finding herself less and less often negligent, and at last has definitely succeeded in forming the habit of good posture. Henceforth her conscious attention to it becomes unnecessary, save, of course, occasionally when she is fatigued. But during the actual process of forming the habit a maximum of attention had to be given to it.

The same general principle applies in the building up of knowledge. Ultimately all our information comes from the outside world. Attention is required in impressing of external situations upon the mind through the process of sense-perception. Conceptual and ideational knowledge, which consciousness abstracts from these products of sense-perception, can only be builded through very fine and discriminating processes of concentration. And finally out of these conceptual and apperceptive units our knowledge systems are organized.

It is obvious from all this that the attentive powers of the pupil need to be trained and developed with all the skill of which an intelligent teacher is capable. The pitfalls into which children may fall in this respect are numerous and dangerous. Scattered attention, half-hearted attention, intellectual dallying, are not only deceitful but inevitably confirm the pupil in attitudes of inattention which will handicap him tremendously in his subsequent habit-forming and knowledge-getting. 'Concentration under full pressure' is the only hygienically sound principle of attention for the classroom teacher. Anything else, though commonly enough found, is both disastrous and unworthy.

QUESTIONS AND PROBLEMS

1. Tests of learning capacity. Names; methods of handling; age for which designed, etc.
2. Grading of children on the basis of learning capacity. In what American school systems is this being done? Methods of determining capacity; results achieved, etc. Differentiated courses of study.
3. Place of the textbook in the lower grades; the intermediate grades; the junior high-school grades; the senior high-school grades.
4. Means of introducing variety into the learning process: in arithmetic; language; history; geography; hygiene; elementary science.

LESSON 14

SECONDARY PHASE OF LEARNING: RETAINING THE DATA

1. MEMORY AND MEMORIES

EXPERIMENTS:

27. *Logical memory test.* For this experiment *E* should first select some piece of connected prose which is easily divisible into its component ideas. He should then divide off idea from idea and count up the total number in the selection, as illustrated in the following from Grimm:

> Near the borders | of a large | forest | dwelt | in olden times | a poor | woodcutter | who had two children | — a boy named Hansel, | and his sister, Gretel. | They had very | little to live upon | and once | when there was a dreadful | season of scarcity | in the land, | the poor woodcutter could not earn | enough to supply | their daily food. | One evening, | after the children were gone to bed, | the parents sat | talking over their sorrow, | and the poor husband sighed | and said to his wife | who was not the mother of his children | but their stepmother: | "What will become of us? | for I cannot earn enough | to support myself and you, | much less the children. | What shall we do with them? | for they must not starve." | "I know what to do, husband," | she replied, | "Early | to-morrow morning | we will take the children for a walk | across the forest | and leave them | in the thickest | part; | they will never find their way home again, | you may depend, | and then | we shall only have to work for ourselves." |

S should be instructed to listen carefully while *E* reads the selection, and immediately at its close to write down as nearly what was read as he can recall, striving especially to reproduce each idea equivalent, though not necessarily *verbatim*, since his score is to be calculated solely on the basis of faithfulness in remembering the ideas. After *S* has completed his version, *E* should compare it carefully with the original, checking off each idea that is found to correspond. *S's* score is the number of correctly reproduced ideas, expressed either absolutely or, preferably, as a percentage of the total number in the original. Time may be saved and the immediate retentivity of the several members of the class compared if the Instructor himself prepares the selection and presents it as a group test. The results in the case of each S are to be preserved in the notebook.

28. *Rote memory test.* (Spanish vocabulary.)

zarza	bramble	además	moreover
retratista	portrait painter	estaño	tin
quebrantamiento	fracture	rencilloso	peevish
desaprovechado	backward	sombraje	hut
tachuela	nail	rebanada	slice
relente	dew	torcedura	twisting
necedad	stupidity	zizana	disagreement
desalmado	impious	travieso	fidgety
cedula	decree	repentino	sudden
abaceria	grocery	almohada	pillow

For this test Spanish words with their English equivalents may be used. Four lists of ten words each should be prepared. Each S is instructed at the signal to study the words in one list until he is able, by covering the words on the right-hand side, to recognize the meaning of each word on the left-hand side. The moment he has thus raised the Spanish words just above the threshold, he acquaints E with the fact, and the latter records the exact time in minutes and seconds which the memorizing process has required. The same procedure is followed with each of the other three lists, S's final score being the average of the four records. All the members of the class should perform the experiment, either by twos or in a group, in which case the instructor acts as E. The results are to be preserved in the notebooks. It will prove interesting to compare the relative standing of each S in this and in the preceding experiment in order to determine whether the individual who is superior in logical learning is likewise superior in immediate rote memory for word meanings. In the event that any members of the class are familiar with Spanish it would be wise for E to construct his lists from Italian or Swedish or some other modern language.

A variation of the experiment may be secured by using lists of ten unfamiliar English words, and directing each S to memorize the list until he can just say it through without error or omission from beginning to end. As in the case of the Spanish vocabulary test, four lists should be learned in this way, and the score for each S taken as the average of the total time required in them all.

29. *Whole and part methods.* E should select beforehand two

pieces of verse of the same length and of approximately the same degree of difficulty. Two sonnets from Mrs. Browning may be easily selected to meet these requirements, as indeed may two non-contiguous stanzas from almost any poem. At the signal, *S* turns over the sheet having one of the stanzas typed upon it and begins at once to learn it, employing the part method. As soon as he is able to repeat the entire stanza without reference to the sheet, he informs *E*, who notes the time taken in the process. After a few minutes of rest, *S* proceeds similarly to learn the other stanza, but employing the whole method this time. Compare the time required in the two tasks. This experiment can be best performed by twos, but if that is not feasible, it can very well be done as a group project, the instructor acting in the capacity of *E*. It will be interesting as a more extended laboratory study to use progressively longer selections in order to determine the ranges in length of stanza in the learning of which either method can most economically be employed by a given individual.

Both this and the two preceding experiments may be used as a means of testing delayed as well as immediate reproduction.

Recapitulation. In an earlier chapter (see Lesson 11) we stated that there are three distinct steps through which one must pass in learning anything: (1) impressing the data; (2) retaining the data; and (3) recalling the data. In the three preceding lessons we have been discussing the first of these: impressing the data. In this and the following lesson we shall seek to find out something of the two other steps. Strictly speaking, retention and recall are two distinct mental processes, the former having to do with the means whereby the brain cells are able to hold the records left by past perceptual or ideational experience, and the latter being concerned with the laws and principles which govern the return of such retained experiences into consciousness. In the interests of unity and brevity, however, while recognizing the distinct identity of each, we shall discuss both these processes of retention and recall under the single general heading: retention of the data.

Memory correlates highly with intelligence. At the outset of our discussion of the memorial processes it will be

[illegible] memory [illegible]
[illegible] of teaching.

well to understand that one's memory — i.e., his *logical* memory[1] — correlates very highly with his general intelligence. A large number of learning tests of various sorts have been conducted, by numerous investigators, and their conclusions are practically unanimous in this respect. Pyle reports the correlation to be as high as .76 for the upper grades. Lyon voices the general findings of the other investigators when he says[2] that those learners "who stand highest in their various studies, and who prove upon examination to be the most intelligent, have, as a rule, the best memories. They not only learn more quickly, but they retain better." It is undoubtedly true that a good logical memory is one of the most vital factors that go to make up that complex function which we call intelligence. Both require

Memory and habit. If we accept as our definition of memory 'that ability of the mind to set up the appropriate response to a given situation,' we shall be in essence giving it the same definition which we have already given to the term habit. And as a matter of fact there is no very hard-and-fast line of division between these two processes, as we have seen. To the situation, '8 × 7,' one responds immediately '56.' Is it memory or habit operating? Or may it be either one, or is it both? It is obviously something that has been learned, retained, and recalled: therefore the process is a memorial one; it is also, however, the result of repetition and drill; therefore the performance is akin to habit. If we contrast the two processes involved in shuffling a pack of cards and reciting the quotation: "the quality of mercy is not strained . . ." etc., the fundamental difference between habit and memory will be better perceived. In the card-shuffling, while ideation undoubtedly is present, the major action is neuro-muscular; in reciting the quotation, while neuro-muscular activity is patent, the major action is ideational.

---

[1] People of rather low intelligence are often found to have fairly good rote memories, but such persons are rarely able to comprehend logical relationships and significances; this is peculiarly a faculty of the intelligent individual.

[2] Lyon, D. O. "The Relation of Quickness of Learning to Retentiveness"; in *Archives of Psychology*, vol. 34. 1916.

In most if not all our responses that have been built up through repetition there is present both neuro-muscular and ideational activity. Those activities in which the preponderating internal response is neuro-muscular we term habits; those, on the other hand, in which ideation preponderates we classify more definitely as memorial. From this it may be readily seen that certain of our responses are difficult to classify as habits or as memories, since they are comprised of approximately similar parts of neuro-muscular and ideational components. In the case of '8 × 7 = ?' we have an illustration of this: the response '56' is both neuro-muscular (voco-motor) and ideational.

Memory differs from habit then chiefly in that it is ideational — one might almost term it 'mental habit' — while habit runs its course largely along the neuro-muscular pathways. But of far more significance than their difference is their similarity. The genesis and growth of both responses depend upon repetition, and in this very vital respect there is no distinction between them. The general law of association governs the operation of both alike. In shuffling a pack of cards, the player makes this movement because he has just made that, and this in turn suggests and initiates the next; the principle of contiguity (see Lesson 9) determines and controls the procedure. In reciting a quotation, the individual concerned recalls this particular line because he has just recalled that, and having so done he is directed by the same principle of contiguity to recite the next, and so on to the end of the quotation.

Memory classified according to rate and duration of acquisition. There is an old adage — more trite than true — which says, "quickly come, quickly go," by which it is meant to imply that those persons who learn rapidly forget also rapidly. The experimental evidence fails to demonstrate the truth of this maxim. Rather it appears that the quick learner is likely in most if not all cases to be the slow forgetter.

The method of getting at this problem in the laboratory we may term the method of delayed reproduction. The subject is given a certain datum to learn. After an interval of several hours or days he is asked to reproduce as many of the ideas learned as he can recall. It is thus possible to compare learners of all degrees of rapidity or slowness with one another, both in original learning and in the number of ideas recalled in delayed reproduction. Almost without exception, where material that was logical in character has been used the experimentalists have found [1] that those who learn quickly remember the longest. Norsworthy found [2] this to be true in German-English vocabulary tests. Gordon concluded from a similar experiment [3] in which Italian-English words were used "that the ones who learned the greatest number of words retained the highest percentage." Pyle, using prose material, found [4] that those subjects who required fewest repetitions retained more ideas after a 24-hour interval. The same investigator reports similar findings from the use of nonsense syllables with mature subjects. Two thousand school children, tested by him with Whipple's "Marble Statue" test for immediate and delayed reproduction, gave confirmation in the case of immature subjects.[5] Numerous other studies seem to warrant the inference that in general the fast learner is a good retainer.

---

[1] Lyon (*op. cit.*) concludes from his rather extensive investigations in this field that, while logical data are remembered longest by those who learn them quickest "with digits it is the quick learners who seem to forget the most. One might make the inference that those who learn *slowly* remember *long* if the material used is such as involves *motor associations*, but that they forget *quickly* if the material is logical in character."

[2] "Acquisition as related to Retention"; in *Journal of Educational Psychology*, vol. III. 1912.

[3] *Educational Psychology*, p. 160.

[4] "Retention as related to Repetition"; in *Journal of Educational Psychology*, vol. II. 1911.

[5] *The Psychology of Learning*, p. 120.

Native capacity to retain varies. When we have concluded that the quick learner generally is a slow forgetter, however, we have not proved that such is always the case. Nor indeed is it. There are marked individual differences in capacity to retain. Some brains are far more efficient retainers than others. Pyle reports, for example, from an analysis of the logical memory of one hundred high-school students, the best memory as being four times as good as the poorest. This striking variation in the native efficiency of the brain cells to retain impressions was first noted experimentally some years ago by Bingham, in a vocabulary test.[1] The existence of four memory types emerged in this test, as follows:

Type A. Quick learner and slow forgetter
Type B. Quick learner and quick forgetter
Type C. Slow learner and slow forgetter
Type D. Slow learner and quick forgetter

We may simplify the types somewhat:

Some quick learners are slow forgetters; others are quick forgetters.

Some slow learners are slow forgetters; others are quick forgetters.

Gordon repeated Bingham's test, and her conclusions correspond closely, as the table will show:[2]

SUBJECT	TOTAL NUMBER WORDS LEARNED	RETAINED AFTER 3 DAYS (per cent)		RETAINED AFTER 3 WEEKS (per cent)	
1	426 words	168 words	39.4	158 words	37.0
2	406 "	138 "	33.9	138 "	33.9
3	365 "	88 "	24.1	77 "	21.0
4	317 "	132 "	41.6	121 "	38.1
5	278 "	78 "	28.	53 "	19.0

---

[1] Bingham, W. V. "The Use of Experiment in Teaching Educational Psychology"; in *Journal of Educational Psychology*, vol. I. 1910.

[2] *Op. cit.*, p. 161.

So also does the quality of the learning. But there is operating another factor which influences a subject's actual retention over a period of time. Mere differences in native retentivity, while accounting plausibly for much of the difference in rate of learning and duration of memory in individuals, cannot explain satisfactorily all cases. There does not seem to be any justification for assuming, on the one hand, that all or even any rapid learners who forget rapidly do so because of fundamental differences in the cortex; nor, on the other hand, that all slow learners who forget rapidly do so for the same reason. Observation of subjects under experimental conditions has demonstrated conclusively to investigators that, as Pyle puts it, "the reason that a quick learner often seems to remember poorly is because he is content with *poor* learning." In other words, there is such a thing as poor *quality* of learning, in which event retention must of necessity be low. Lyon, who has experimented as extensively as any one in this field, claims never to have found a case of a subject whose learning was of good quality being a poor retainer. The trouble with the quick learner who forgets quickly is more than likely to be over-self-confidence in his own ability to do the task; this leads him to throw caution and care to the winds and get the required results as quickly and easily as possible. If one could but arouse such poor-quality learners to bring a little greater diligence to their tasks, it is not improbable that they would be found to retain as well as the best.

The slow learner who retains poorly probably stands in somewhat the same relationship to the slow learner with the good memory: he uses poor methods; the quality of his application is below par. The trouble with him often is over-consciousness of his few talents and lack of confidence in his learning abilities generally. Arouse him to a commendable feeling of faith in himself and he will, in most cases, be found to learn and retain as well as the other slow learner who employs careful methods and slowly but resolutely grinds out the grist. Until we have more experimental evidence, which we badly need, we may conclude that, while brains do differ markedly in their ability to retain, a considerable portion of the responsibility for individual differences in retentiveness is functional rather than structural, psychological rather than neurological.

Age or maturity a factor in retentivity. Contrary to a rather prevalent opinion, the capacity to learn and the ability to retain are not greatest in childhood, but increase rather uniformly up to early adolescence, and then more slowly through the remainder of the period up to the attainment of maturity, remaining fairly constant thereafter until middle age. There appear to be, however, fluctuations in memorial ability after puberty. Thus, Pohlmann found substantial progress in his subjects up to the fourteenth year, and then in the fifteenth year a sharp drop to the level of the eleventh year, with a rise again at sixteen, and so on fluctuatingly to the twentieth year, but without reaching again the high level of the fourteenth. Pohlmann's table (quoted from Whipple) indicates this.

TABLE VII. NET EFFICIENCY OF VARIOUS MEMORIES IN RELATION TO AGE (POHLMANN)

AGE	9	10	11	12	13	14	15	16	17	18	19	20
Average Capacity	39.4	41.4	55.7	59.1	62.1	68.9	55.3	62.9	58.6	58.0	65.4	68.3

Such studies as that of Pohlmann and others lend credence to the common notion that in the early teens there exists a golden 'memory period,' when ability to commit to memory is at its height. Other investigators, notably Jacobs and Smedley, fail to find evidence of the existence of any such period. Most investigators are agreed, however, that notwithstanding possible fluctuations, and taking into account the different forms of memory (i.e., memory for objects, digits, sounds, logical memory, rote memory, etc.)

memory in general grows with age, period by period, from early childhood up to maturity. As one might expect from their physical advantage, girls are uniformly superior to boys in capacity to retain previous at least to the sixteenth year.

Memory classified according to method used in impressing the data. The conventional method of procedure, supposing one has a poem of, say, half a dozen or so stanzas to memorize, is to learn it line by line, or stanza by stanza. The term 'part method' has been fittingly applied to this method, since a selection learned in this way may be said to be learned by parts. It is the method commonly used by children who have declamations or other data to learn verbatim. Adults also naïvely employ the same method in most memorizing which they may be called upon to do.

Experimental results have indicated that for most people and within certain specific limits, a piece of poetry or prose can be memorized more economically in point of time by what is termed the 'whole method.' The procedure under this method consists of reading the entire datum through from beginning to end, times enough to be able to recall it entire. There are at least two reasons why the whole method is to be preferred over the part method. In the first place, the learner using the latter procedure, after he has learned one line or one stanza, commonly goes back to repeat the preceding line or stanza or stanzas, thus forming false association sequences which must be broken up later on. Secondly, employment of the part method obviously leads to a far greater number of repetitions of the first portion than of the subsequent parts of a selection. The spectacle of a child 'speaking' a piece, proceeding beautifully through the first few lines and then having to be prompted assiduously throughout the rest of it, is not uncommon! He has repeated the earlier lines dozens of times more than the later ones. The advantage of this method is obviously the encouragement which the learner experiences as he finds himself able, after a moment or two, to recall the first lines: he is aware of making progress, and this is a considerable factor where young children are the learners. Use of the whole method, on the other hand, affords no such encouragement. It may be that after fifteen minutes, or even a half hour, spent in reading and re-reading the passage the learner is at a loss to recall the first line, although when logical rather than rote memory is being used this objection disappears.

The whole method possesses the advantages: (1) of being more economical of time; (2) of building up no wrong sequences of associations through frequent return to a preceding line or lines; and (3) of necessitating an even distribution of repetitions to all parts of the datum, treating it as an indivisible unit. Its disadvantages undoubtedly are: (1) its tardiness in yielding tangible results; and (2) its greater cumbersomeness and unwieldiness, since it compels the learner to devote an equal amount of attention to the easier parts and does not permit him to devote additional repetitions to the more difficult and involved sections.

To avoid the disadvantages of both the whole and the part methods, and at the same time to take advantage of their good points, practical teachers find a combination method, which has been appropriately called the 'whole-part' method, to be of value. The learner first goes through the whole selection a few times in order to get the general idea of it clearly in mind, and to discover what are the more difficult parts which will require special concentration. Having thus 'sized up' the datum, he proceeds to focalize upon the difficult or involved portions for a time, subsequently going over the whole again from beginning to end several times, preferably referring very sparingly to the text. In teaching poems to primary and intermediate children, for example, teachers report excellent results from the use of some form of the whole-part method. It is, obviously, likewise of value as a method of studying logical material.

Memory classified according to arrangement of the data

in the mind. Memory is further to be classified in terms of the order or arrangement which the materials learned or the situations encountered take in the mind. Three types of memory are to be distinguished on this basis: (1) desultory memory; (2) chronological memory; and (3) logical memory. The first of these — desultory memory — is, as its name implies — a form of retention in which the ideas retained have no order or coherence, but just 'stick.' Memories of this type are ordinarily rambling, erratic, and unmethodical, and the associations which they gather in the mind are largely accidental. The mind of the child is notably of this sort. Lacking the necessary background of experience to be able to sort and classify his experiences, yet at the same time passionately eager to multiply them, he cannot but amass a heterogeneous hodge-podge of disconnected and disjointed images and ideas: the "great, blooming, buzzing confusion" described by James. Many grown-ups are also possessed of desultory memories: their brain cells are very faithful retainers but poor connecters and organizers of the impressions which they have received.

Chronological memory characterizes those individuals who have very special and faithful memory for words which they have read or heard.[1] Minds of this type are often veritable storehouses of rote data serially connected. The eyes as it were photograph the printed page, and it is transmitted sharply and indelibly to the cortex. Witness, for example, the ability of a certain member of the British Parliament who was able to repeat verbatim long legal documents after a single reading.[2] The gentleman was wont to complain, however, that his remarkable verbal memory was very often a vexing handicap to him, inasmuch as he often found it necessary to repeat from the beginning a long Act or other document in order to bring to mind a particular paragraph or sentence of it which he needed at the moment.

---

[1] Most psychologists, following James's original terminology, do not differentiate between desultory and chronological (or rote) memory, including within the meaning of desultory memory both desultory and rote. The author is of the opinion, however, that the distinction as made in the text is a helpful one.

[2] Cf. *Mental Physiology*, by William B. Carpenter, p. 451.

As illustrative of the tedious phonograph play of the chronological type of mind, which must reproduce exactly in accordance with the original impression series, James cites[1] the following quotation from Jane Austen's *Emma:*

> "But where could *you* hear it?" cried Miss Bates. "Where could you possibly hear it, Mr. Knightley? For it is not five minutes since I received Mrs. Cole's note — no, it cannot be more than five — or at least ten — for I had got my bonnet and spencer on, just ready to come out — I was only gone down to speak to Patty again about the pork — Jane was standing in the passage — were not you, Jane? — for my mother was so afraid that we had not any salting-pan large enough. So I said I would go down and see, and Jane said: 'Shall I go down instead? for I think you have a little cold, and Patty has been washing the kitchen.' 'Oh, my dear,' said I — well, and just then came the note. A Miss Hawkins — that's all I know — a Miss Hawkins, of Bath. But, Mr. Knightley, how could you possibly have heard it? for the very moment Mr. Cole told Mrs. Cole of it, she sat down and wrote to me. A Miss Hawkins —"

Memory of the chronological type has its good points, however. One can hardly conceive of a great actor or a great musician having other than an excellent memory of the rote sort. The same would appear to be true of great orators and first-rate linguists, as well as of all other individuals whose art is dependent upon the ease and faithfulness with which serially related data can be reinstated memorially.

Logical memory characterizes the retentivity of persons whose brains excell in their cleverness at sorting, ordering, and classifying the data which they receive. The mere contiguousness of experiences is broken up, and each new impression is 'pigeon-holed,' as it were, with other related impressions previously registered. Children have, as a rule, poor logical memories. Adults very commonly have excellent ones. Thoughtful, mature minds such as those of the student, the philosopher, the thinker in any realm, the scientist, and the talented generally, belong in this class, as do those of all of us who definitely organize our knowledge and systematize it. We shall have more to say of this type of memory in the section entitled, Organization of Associations, a little further on.

---

[1] James, W. *Principles of Psychology*, vol. I, p. 571.

Number of associations a factor in retention. Some of our knowledge is impressed very easily upon the cortical cells, requiring few connecting links of association and being subject invariably to immediate recall. Such, for example, may be said of our memory for highly interesting or intense experiences, like witnessing an exciting contest or a fatal accident. The greater part of our memorial activities, however, would be either very tardy or else quite impossible were it not for the fact of their being intimately connected with one another in the association areas of our brains. Other things being equal, the greater the number of different ideas associated with a given idea, *x*, the more easily and certainly *x* will be aroused and drawn into consciousness by virtue of the pull of the associates. In the event of any one of the associated ideas *a* being temporarily or permanently blockaded, there remain ideas *b*, *c*, *d*, and *e*, etc., some one of which will ordinarily suffice to arouse *x* and force it into focal consciousness. Only in case all the associates are forgotten will *x* remain elusive. This circumstance in itself suggests the importance of the learner forming as many associations as possible. In the words of James, "the more other facts a fact is associated with in the mind, the better possession of it our memory retains. Each of its associates becomes a hook to which it hangs, a means to fish it up by when sunk beneath the surface."[1]

To illustrate: Suppose it is desired to recall the approximate date of the reign of Queen Elizabeth (1558–1603).

---

[1] James, W. *Psychology, Briefer Course*, p. 294.

The person endeavoring to reinstate the date of her reign we may assume has, in his previous experience, at some time or other established the following associates with Queen Elizabeth: (1) that she was the daughter of Henry VIII (and Anne Boleyn), who died around the middle of the sixteenth century; (2) that Elizabeth's hand was industriously sought in marriage by Philip II of Spain, who ruled in that country in the middle of the sixteenth century; (3) that Sir Walter Raleigh was one of Elizabeth's favorites, and that Raleigh established the first English colony in America on Roanoke Island, in the last quarter of the sixteenth century; (4) that Spenser composed *The Faërie Queen* professedly to extol Elizabeth's virtues, and that Spenser and Shakespeare, who lived in the sixteenth century, were contemporaries; (5) that the *Midsummer Night's Dream* was written for Elizabeth's amusement by Shakespeare, and that Shakespeare wrote in the sixteenth century; (6) that Sir Francis Drake first circumnavigated the globe during Elizabeth's reign, and that the date of that event was in the latter part of the sixteenth century; and finally, (7) that to the general period covered by Elizabeth's reign history has given the name: the Elizabethan Age, the age of literature, colonization, discovery, Baconian science — the sixteenth century. In the event of any one, or two, or a half-dozen of these associations with the period of Queen Elizabeth being temporarily forgotten, there is the almost inevitable likelihood that at least one of them will be aroused, and so the desired connection established.

So with all memory, whether it be of historical incidents and developments; of geographical locations, products, etc.; of principles or processes of elementary science; of mathematical formulæ or procedures; or of any other topics in the general subjects of the school curriculum — the greater the number of associated ideas, thoughtfully connected and organized, the more dependable and definite the recall of any desired experience.

Organization of associations an equally important factor

in retention. We took occasion in a preceding paragraph to refer to the logical type of memory as characteristic of those individuals whose brains are clever and indefatigable sorters, organizers, and classifiers of the data which they receive. We shall now develop that topic somewhat more in detail, since careful organization of ideas in the mind is one of the most prominent factors of a good memory. As we pointed out above, the immature person shows little inclination to classify and systematize his impressions. The mature, thoughtful person, however, strives to unify and coördinate his knowledge by grouping facts that belong together, by arranging ideas according to various principles, and by carefully relating each new experience to appropriate experience-clusters which he has already assembled. This is preëminently the method of the scientist who is able to build up inductively the sum total of human knowledge, or who seeks to apply deductively formulæ or principles that have been already established. Exact knowledge is possible only through the painstaking, patient, and often very delicate integration of the experimental data obtained by scientific workers in field and laboratory.

But the scientist is not the only person who must exercise care and discretion in the organization of experience; every one of us who proposes to develop a dependable and an economical memory must needs follow the method of the scientist. We cannot afford to permit the facts and ideas which we gather from experience to be massed helter-skelter in the brain cells. Nobody has much admiration for the housewife who spends a large part of her day hunting for mislaid or lost articles that may be found in any one of a dozen or more places; nor for the workman who spends as many minutes hunting for his tools as he does in using them. On the other hand, we do admire the person who keeps his belongings fairly well sorted and arranged, and is in consequence able to get his hands on any of them with the minimum of delay and confusion. This is at best a homely simile, but it does illustrate the importance of well-organized and integrated mental experiences. An illustration or two will be helpful.

Illustrations of good organization. In studying the history of the American Revolution, for example, the student who merely reads a hundred pages of text from some source book will find, a month or so later, that his knowledge about the Revolution is very meager indeed. On the other hand, if, by careful reflection and organization of the material, he has not rested content until he has worked the facts and events of the period into a systematized and coherent form, his memory of the struggle of the colonists for independence will be inestimably more dependable and integrated. He will arrange about the main topic Causes which led up to the War, one series of ideas, notably the Navigation Acts and their effect upon American commerce; smuggling and Writs of Assistance; the temper of George III; the Sugar Act; the Stamp Act; taxation without representation; etc.

Under the topic Events, he will build up another series of ideas: the Boston Tea Party; the Minute Men; Lexington and Concord; the Second Continental Congress; Bunker Hill; the British driven from Boston; the war in Long Island and New Jersey; Howe and the Brandywine; Valley Forge; French aid; Paul Jones; surrender of Cornwallis; Lafayette, etc. Other topics that he will need to organize carefully include: popular opinion in England concerning the policy of George III; sympathy of other nations with the colonists; Whigs and Tories; the Declaration of Independence; the war on the sea; parallel revolutionary movements in other countries; reconstruction during the 'critical period,' etc., etc. By thus thoughtfully analyzing the history of the Revolutionary period into several prominent main topics, and searching through and comparing sources, the student finally has built up his knowledge of the War into a strongly cemented structure which will not easily crumble.

Suppose, as another illustration, a seventh-grade class is to study the story of iron. If the children have learned how to study effectively they will proceed, working either individually or by groups, to discover in the source books as many facts relating to the general topic of iron as possible. Having exhausted the available references they will undertake to organize in topical or paragraph form the data they have collected. A typical result (in bare outline) would be somewhat as follows:

The Story of Iron

I. Iron known and used from earliest times.
  a. By Europeans, Asiatics, and Africans.
  b. Superseded earlier stone.
  c. Used extensively for fashioning tools and weapons.
  d. Primitive charcoal method of smelting iron.
    1. This method used by modern man up to about one hundred years ago.

II. Modern methods of smelting iron.
  a. The furnace.
  b. The ingredients.
    1. Coke.
    2. Limestone.
    3. Ore.
  c. 'Cooking.'
  d. Pigs.
  e. The steel mill.
    1. Moulding and cooling.
    2. Rolling.

III. Pittsburgh, the greatest iron center in the world.
  a. In heart of soft coal region.
    1. Coke, formed from soft coal, used instead of charcoal for smelting.
  b. Natural junction of railroads of western Pennsylvania.
  c. Ore from Duluth easily transported.
    1. Down the lakes to Cleveland.
    2. From Cleveland to Pittsburgh by train.
  d. Pennsylvania ores poorer in quality than those in the Lake Superior region.

One of the most essential aims of every teacher should be the encouraging of the learners of every subject in the curriculum to organize clearly and logically the data which they amass from day to day in their study. To this end she must not only take care to make assignments in such a way as to suggest orderliness and system to those who are to investigate them, but she must so conduct or direct the recitation period as to stimulate even the slowest learner to group and relate the information he has gathered. Pupils should get into the way of stopping to ask themselves frequently such questions as: "What is it exactly that I am striving to do?" "How does this fact bear upon my problem?" "What facts which I already have in my possession are possibly related to this fact, and to my problem?" "What elements of my problem need still further light thrown upon them?" "How clear and definite are the ideas which I am deriving in my investigation?"

Not memory, but memories. One is often inclined to say of himself, 'I have a poor memory,' or, 'I have a very good memory,' implying that memory is a general faculty of the mind. The experimental evidence, however, rather upsets this theory. An individual appears to have a different memory for almost everything he retains, and one ought in consequence to speak, not of 'memory,' but rather of 'memories.' In our everyday experience we find evidence of this disparity of memorial capacities in the circumstance that the same individual may have a poor memory for names, but an excellent memory for faces; a poor memory for dates, but an excellent one for telephone numbers, etc. He may retain the words of a foreign language well, but be a rapid forgetter of historical events; he may hold fast mathematical formulæ and at the same time be bereft speedily of the content of literary masterpieces.

It used to be commonly believed that memory was a very general capacity, and that it was trained by whatever memorial activities its possessor engaged upon. Thus, Latin and Greek, in common with mathematics, were deemed to be excellent gymnastic material, it being assumed that just as swimming developed the muscles of arms, back, and legs simultaneously, so exercising the memory upon the ancient languages or mathematics made it for that very reason more effective in retaining all other sorts of data. We shall consider this whole question of transference, or formal discipline, in Lesson 16, and it is not our purpose here to anticipate that discussion further than to point out the improbability of any great transfer of memorial ability from one field to another, and the consequent error in the assumption that one's memory is a general function of his mind. We train only what we train; and if it is retention of Latin meanings that we train, we are not training memory for geographic or historical or biographical or other materials than Latin meanings.

Another explanation of the fact that a person's retentivity for one type of facts is likely to be much better or poorer than for another is to be found in the matter of his attitude toward the several types of data. What with his past experiences, and the likes, dislikes, interests, and prejudices which he has formed, it is small wonder that he should find certain things much easier to retain than certain others. The marvel perhaps is that the discrepancies between his several memories are not greater than they are. It is not unlikely that if all one's experiences, subjectively as well as objectively, could have been precisely similar with all the materials of knowledge, he would be found to be possessed of equal memorial efficiency with respect to all those materials. Owing to the great diversity of experience, however, we discover that his memory is a somewhat complex capacity, varying in efficacy with every sort of datum. It is this fact which justifies us in referring to the function as 'memories' rather than as 'memory.'

QUESTIONS AND PROBLEMS

1. Factors that make for 'poor' learning.
2. Grading methods that recognize and provide for rapid and slow learners.
3. Investigations into the question of age as a factor in learning achievement.
4. A good procedure to use in teaching a poem, like *Old Ironsides* to a sixth-grade class.
5. Helping a learner of the desultory type of memory to develop a logical one.
6. Hints for the teacher to follow in order to provide adequately for number and organization of associations on the part of the pupils. (Illustrate by a lesson plan for teaching 'Coal'; 'Causes of the Civil War'; 'Growth of New York City'; etc.)

SELECTED REFERENCES

1. Breese, B. B. *Psychology*, chapter 10.
2. Gordon, K. *Educational Psychology*, chapter 10.
3. James, W. *Psychology, Briefer Course*, chapter 18.
4. Pyle, W. H. *Psychology of Learning*, chapter 7.
5. Strayer, G. D., and Norsworthy, N. *How to Teach*, chapter 5.

[illegible]

LESSON 15

SECONDARY PHASE OF LEARNING: RETAINING THE DATA

2. FORGETTING, IDEATION, AND TRAINING

EXPERIMENTS:

30. *Type of presentation of a datum.* *E* prepares beforehand four groups of nonsense syllables in series of twelve. One series is to be presented orally to *S* (i.e., auditory presentation); the second, visually; the third, both orally and visually; the fourth presentation may be simultaneously oral, visual, and articulatory. In the case of the orally presented series, *S* should be instructed to close his eyes and keep his tongue pressed firmly against the roof of his mouth in order to rule out as far as possible all perception save that of the auditory type. The syllables should be pronounced clearly and without rhythm or grouping, and after each presentation *S* should repeat orally as many as he can recall. *E* records the number of presentations necessary for *S* to be able to recall the entire twelve in immediate reproduction. The syllables should be presented at the uniform rate of one per second; a metronome, set at 60, will be helpful in this connection. In the visual presentation of the second series of twelve syllables, the same procedure is followed, except that visual perception is employed; in the third series, both auditory and visual are used; and in the fourth *S* is instructed to pronounce each syllable to himself as he sees and hears it. *S* keeps an accurate record of the number of repetitions required to impress each of the four series.

31. *Rate of forgetting.* A method commonly employed in the laboratory to measure the rate of forgetting is that of determining the ratio between the time required to relearn a datum after intervals of various lengths and the time originally consumed in impressing it. To illustrate the method, *E* should prepare a series of twenty-four nonsense syllables, which he presents to *S* with instructions to learn them to the point of immediate reproduction without error. *E* keeps a careful record of the exact time required. After an interval of twenty minutes the same series is again presented to *S*, who is instructed to relearn them to the same point of

immediate reproduction. The time required in relearning may be taken as the measure of the amount of forgetting during the interval. Thus, if eight minutes are required for the original learning, and two minutes for the first relearning, it is obvious that twenty-five per cent as much time was required to relearn as to learn. This would indicate twenty-five per cent of the datum had been forgotten. The same procedure should be followed after intervals of one hour, six hours, twenty-four hours, two days, three days, one week, etc. The selections used in Experiment 29 (see Lesson 14) or other logical material may be used instead of or in addition to nonsense syllables if it is desired. After the experiment has been completed each *S* should construct his curve of forgetting for each sort of material employed.

Importance and rate of forgetting. Having learned, we straightway proceed to forget. And it is a matter of economy that one does thus forget. Were his mind to be cumbered forever after, or even for a considerable space after, with the thousand and one details of a day's experience, one could hardly hope to keep intellectual order in his brain cells. The decks must be cleared for subsequent action. It is after all only the significant and the important that we need to remember. Non-essential, transient, and incidental impressions would be in the way if we were to attempt to hold them in the mind.

That the mind happily fails to register many of the details attendant upon experience we may demonstrate for ourselves by endeavoring to recall facts about certain objects in our everyday experience. Thus, Meumann reports[1] making systematic inquiries of students concerning their memory of the wall-paper of the rooms in which they studied; of dishes that they used at table customarily; of steps in the University stairways; of buildings which they passed daily; of striking church spires in the city, etc., etc., and finding "exceedingly uncertain and even erroneous answers." Apparently mere repetition of impressions is not sufficient to arouse memory. Connected with the reception of the impressions must be the avowed and definite purpose to remember. The unfortunate part of it is that even with the best determination to retain we not infrequently fail in our efforts, and consequently even the essential thing is forgotten.

---

[1] Meumann, E. *The Psychology of Learning*, p. 315.

Forgetting is, then, a perfectly natural process. It is also one whose rate can be definitely measured and formulated into a general law, which may be stated thus: forgetting goes on very rapidly immediately after the completion of the act of learning, but thereafter more and more slowly until a phase is reached wherein the loss, from day to day, or from week to week, is practically negligible. Even within an hour after the completion of the learning some of the material — Ebbinghaus concluded more than half — has been forgotten. Ebbinghaus's method[1] was to memorize a large number of nonsense syllables, 13 to the series, up to the point where he could just recite a series without error. After definite intervals of time had elapsed he proceeded to relearn the series, taking as his measure of the rate of forgetting the time required for relearning. Table VIII gives his results for the several intervals.

TABLE VIII. RATE OF FORGETTING (EBBINGHAUS)

NO. SERIES OF NONSENSE SYLLABLES LEARNED	LENGTH OF INTERVAL BETWEEN ORIGINAL LEARNING AND RELEARNING	PER CENT FORGOTTEN
12	19 minutes	41.8
16	63 minutes	55.8
12	525 minutes	64.2
26	1 day	66.3
26	2 days	72.2
26	6 days	74.6
45	30 days	78.9

---

[1] Meumann, E. *The Psychology of Learning*, p. 330.

From these data Ebbinghaus first stated the general law concerning the rate of forgetting which has, in the main, been substantiated by other investigators, notably Radossawljewitsch and Meumann.

Radossawljewitsch repeated Ebbinghaus's original experiment with twenty-seven observers. He found that, while the latter's general conclusions held valid, his results showed forgetting to proceed much too rapidly during the period immediately succeeding the learning. Table IX shows Radossawljewitsch's results.

TABLE IX. RATE OF FORGETTING (RADOSSAWLJEWITSCH)

No. Series of Nonsense Syllables Learned	Length of Interval between Original Learning and Relearning	Per cent Forgotten
24	20 minutes	11.4
24	60 minutes	29.3
24	480 minutes	52.6
47	1 day	32.2
26	2 days	39.1
20	6 days	50.7
18	30 days	79.8

Fig. 29 represents the results of Ebbinghaus's and Radossawljewitsch's experiments, plotted in the form of curves.

Aside from the noticeably slower rate of forgetting which Radossawljewitsch found to obtain during the period immediately following completion of the learning, the only other item of interest in his results is found in the circumstance that his subjects remembered more after the twenty-four-hour interval than they did after the eight-hour one, the explanation doubtless being, as Meumann points out[1] the appearance of a general mental fatigue during the day, which makes retention more difficult, and the growth in strength of the associations during the first twenty-four hours.

---

[1] *The Psychology of Learning*, p. 332.

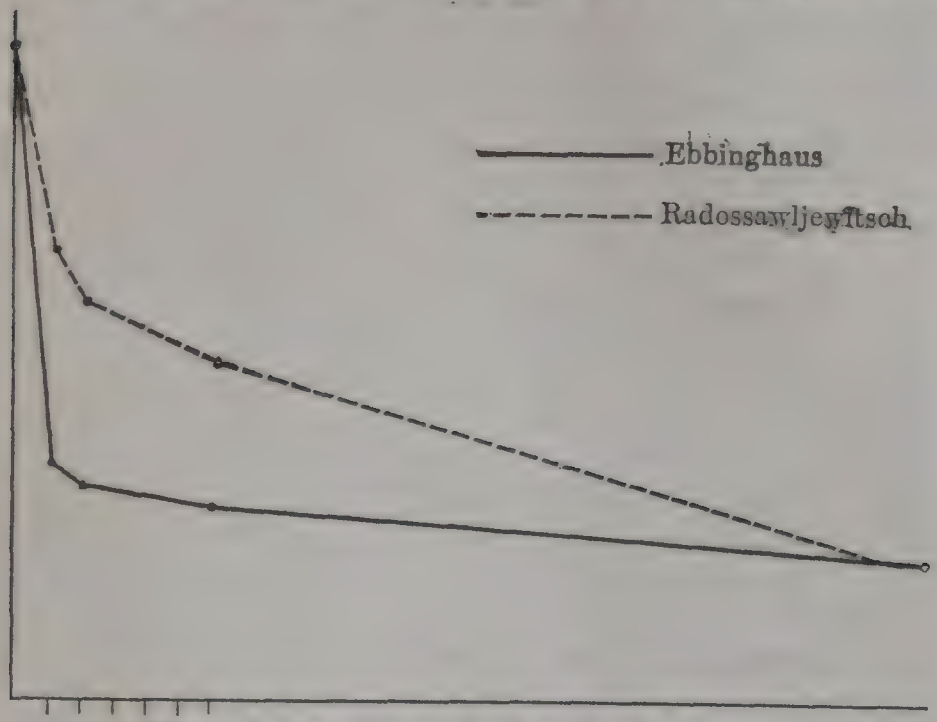


Figure 29. Curves showing Rate of Forgetting

The importance of over-learning. It is an unfortunate tendency of most learners — particularly juvenile — to stop the learning process the moment the datum can just be recited from memory. While such a minimum of repetitions may be all that is required, in the case of materials that it is not desired to retain permanently, it is a fact that by far the greater part of the associations that are built up in the schoolroom are supposed to be builded permanently. To guarantee a reasonable perpetuity of such associations it is highly important for the learner to 'over-learn'; otherwise permanence of impressions is extremely dubious.

As we have noted in a previous connection, the unfortunate tendency of the quick learner to stop too soon results

13 nonsense syllables
[illegible]

in his being a rapid forgetter. Through drill and thorough discussion, therefore, the teacher should take constant pains to assure herself that the pupils are thus over-learning, at the same time of course bewaring lest the process become so monotonous that interest lags and attention scatters.

Relearning in the schoolroom should be frequent. Since the phenomenon of forgetting is an inevitable sequel to all learning, it follows that the educative process must take it into account, and provide as far as possible against an excess of it. This is made possible by frequent reviews of material that it is particularly desirable to have retained reasonably intact. In such subjects as arithmetic and, to a certain extent, spelling and formal grammar, where the very nature of progressive study necessitates daily drill of certain fundamentals, the pupil's acquisitions are tolerably permanent. In other subjects, such as history and geography, however, the cumulative effect is not so much in evidence, and consequently special attention must be given to reviews.

Inasmuch also as forgetting proceeds most rapidly immediately after original acquisition, it is apparent that the reviews should occur as soon after the initial learning as possible. The custom of many teachers of having a brief daily review of the preceding day's work is justified, psychologically.

Individual differences in rate of forgetting considerable. As we saw in the preceding lesson, some quick learners forget quickly, others slowly; some slow learners forget slowly, others quickly. This simply means that the curve of forgetting is strictly an individual matter for all of us, although it will be found in general to proceed as we have indicated in a preceding paragraph.

In order to aid those of her pupils who are quick forgetters because they are poor learners (see p. 305) to retain up to the maximum of their native abilities, the teacher will need to maintain careful oversight of their methods of study.

In most cases merely showing them how to study will prove a great boon to their retentive powers. They must be led not only to 'over-learn' but to observe the principles: (1) of number of associations, and (2) of organization of associations. Some of them will need to have their confidence in their own abilities strengthened; others will profit from being led to understand that, while confidence and assurance are strong virtues, they must be tempered and controlled by conscientious and earnest work. "Every lesson thoroughly learned and thoroughly understood by every pupil" must be the slogan of the teacher.

There is little doubt but that one of the gravest faults of our present-day system of elementary education is the inclusion within its curriculum of so many subjects. The number of subjects being large, the correlation poor, the rate of progress rapid, and the grading of the learners often on a questionable basis, it is small wonder that the end results are not always as secure as we should like them to be. In order to bring about the finest possible educational product in the face of these recognized difficulties, the teacher will do well to adopt the ideals mentioned in the preceding paragraph as a part of her professional philosophy.

Time interval between different impression series important. If immediately after learning a series of nonsense syllables, with sufficient thoroughness to raise them just barely into memory, I turn at once to learn another datum or to perform any kind of mental work, I shall find my retention of the nonsense series much less efficient than would be the case had I waited a few minutes before engaging in another learning process. It appears to be the case, in other words, that impressions received by the brain cells in a memorial exercise require a certain minimum amount of time in which to 'set,' if our retention of them is to be anything like permanent. We may liken this 'setting' process, although the figure is in other respects wholly misleading, to the solidifying of a dish of gelatine; previous to hardening, it is easily disturbed, but afterward it is firm

Retroactive inhibition is one idea interfering with another

and resists dissolution with some tenaciousness. Pillsbury explains[1] the process thus:

> The new work seems to interfere with some continuing activity of the nervous system that is essential to the best retention. This 'setting' of the associations after learning is probably what makes distributed repetitions more effective than accumulated ones. . . . The nerve cells continue to act for some little time after the conscious processes have ceased, and the associations continue to increase in strength during this period. New work interferes with this activity, and prevents the associations from reaching their full strength. This so-called *retroactive inhibition* is analogous to the retrograde amnesia of the psychiatrist. This technical term means that a mental or physical shock will destroy memories of events that have immediately preceded, and that may be assumed to be represented by associations that have not completely 'set.' . . . A lesson will be better remembered if one will wait three to six minutes after finishing it before turning to another task.

In the interest of guarding against retroactive inhibition, the teacher should, so far as possible, plan to introduce a 'breathing space' between lessons. This may take the form either of relaxation or of a mild calisthenic, the movements of which are so familiar to the pupils as to necessitate the expenditure of very little cerebral energy. More experimentation is necessary before we can intelligently make further recommendations concerning the ideal means of filling in the brief spaces which we know ought to obtain between the study of different subjects.

Excessive forgetting is due to violation of principles of learning. As we have noted in previous paragraphs, forgetting is inescapable. When, however, a normal person is found to be an abnormal forgetter, the explanation must be sought in some violation or other of the general laws of learning. Either there has not been enough repetition, with attention, in the original learning; or there have been too few associations formed; or the material has not been well organized and systematized; or reviews have not been properly handled, so that normal retention could obtain; or else some other important condition has been neglected. The sagacious teacher will guard against an excessive amount of forgetting by observing faithfully the laws, principles, and conditions of good learning in her direction and supervision of the study of her pupils. Daily reviews and frequent quizzes — oral and written — will make it evident to her whether her methods are sound in this respect.

---

[1] Pillsbury, W. B. *Essentials of Psychology*, p. 196.

Ideational types. It was a French psycho-pathologist, Charcot,[1] who made the discovery that different individuals are possessed of different ideational types. One of his patients who had, previous to a serious illness, been a strong visualizer, was almost completely bereft of his power to retain visual images, and was compelled to rely chiefly upon auditory imagery as a substitute for the lost ability to visualize. A familiar person he recalled now only through hearing him speak, and so recognizing his voice. Since Charcot's original discovery of the fact of ideational types, numerous investigators have given considerable attention to defining and interpreting them. We may classify the chief ideational types, as they have been worked out, somewhat as follows:

Study

CONCRETE IDEATION	VERBAL IDEATION	COMBINATION OF CONCRETE AND VERBAL
Visual Auditory Motor	Visual Images of words Images of writing movements Auditory Motor Images of vocal movements (Voco-Motor) Images of writing movements	Visual concrete and Auditory-Motor Verbal

---

[1] Charcot, J. M. *Leçons sur les maladies du système nerveux.*

From this scheme it is obvious that some individuals are compelled in their thought life to depend chiefly upon ideas that they retain of concrete objects which they have perceived; that other individuals depend largely upon their memory for words; and that still others belong to what may be termed a 'mixed type' in which both concrete and verbal images are combined.

Concrete ideation. In the first of these, concrete ideation, an individual may be predominantly visual, auditory, or motor in type. The visualizer habitually retains his experiences in terms of visual images of concrete objects. Each impression he receives is translated into a visual picture and stored up intact as a memory image. There are records in the psychological literature of individuals who possess little short of uncanny ability to retain visual images of past perceptual experience. The majority of persons doubtless are concrete visualizers, so far as their retention of concrete, non-verbal experience is concerned.

The individual of the auditory type tends to retain concrete experience in terms of auditory images, usually supplemented by verbal-motor imagery. Such persons, instead of recalling visual pictures of their past perceptions, find the dominant activity of their minds in recall to be reinstating their auditory and verbal-motor aspects. Unable to recall 'red,' for example, by visual imagery, they remember that particular color as 'something that is called red,' or they 'call to mind the circumstances under which the color was seen and these will enable them to recall the color.'

The motor-minded individual tends to retain concrete experience in terms of motor ideation of movements or of situations. He reëxperiences in memory images of the same muscular tenseness or strain which he experienced during perception. Thus, he recalls witnessing an accident by vivid innervation of the visceral and other groups of muscles; he recalls a football game by a tension of leg, shoulder, and other muscle groups. Persons of this type of imagery, in the words of Meumann, "project themselves into situations in which they are interested, and experience such sensations as would result from one's active participation in such situations." The memorial process brings back these movements emphatically. The German term for this tendency (*Einfühlung*) is a suggestive one.

We should bear in mind in this discussion that individuals of the pure visual, or of the pure auditory, or the pure motor type of concrete ideation are not very common. Most of us receive stimuli from any given situation through the medium of at least two and commonly of three sense departments. Memorial reinstatement of our experience is not therefore limited to any one group of images (visual), but commonly occurs in terms also of one or more others (motor, tactual, etc.).

Verbal ideation. The second class of individuals comprise those whose memory is characteristically of the verbal rather than the concrete kind. The verbal visualizer has visual images of printed or written words; the individual of the verbal-auditory type thinks in heard words; the verbally motor-minded either in images of actual movements of the vocal cords or in images of writing movements. In many cases the motor imagery is so vivid that not only are the speech muscles innervated, but the lips and tongue are actually observed to move slightly during the thinking process. The expression 'inner speech' has been very appropriately applied to verbal-motor imagery in which the oral apparatus tends to receive innervation. Leibnitz interpreted thinking as a "silent speaking," and so indeed it appears to be in persons in whom voco-motor imagery is conspicuous. This silent, inner speech is not unlike a soft whisper which, in our thinking, writing, and speaking anticipates the words we are to use and flashes them before us in voco-motor imagery which is always hastening on a word — or a thought — before us. Thus, some days ago, in preparing a lecture, I chanced to have occasion to write down in my notes the words 'spoiled children.' This is what I wrote: "spoilch —." Here my inner prompter was proceeding faster than my pen could keep pace; hence in my haste to catch up I inadvertently used this short cut.

It must be borne in mind, in addition to the fact that individuals of pure concrete imagery are rare, that few of us carry on our thought life exclusively either in concrete or verbal imagery. We may generalize best, perhaps, somewhat as follows: In memorial processes in which the imagination holds sway, most persons tend to ideate in concrete images; while in processes in which active, purposive thinking, reasoning, or judging predominates, they tend to ideate in verbal images. The concrete ideation is most typically of the visual type; the verbal is most typically of the auditory-motor. Meumann explains:[1]

> The more concretely my imagination works, the more do my verbal images retreat to the background of consciousness; the more intent I am upon following an abstract train of thought, the more do I think in terms of internal speech. . . . Fundamental differences of individual endowment have their foundation in the opposition between these two sorts of ideating. Artists and musicians seldom show an inclination toward scientific thinking; and leaders in science are usually indifferent artists. From the introspective analysis of numerous individuals of both groups, one can see clearly that concrete ideation is dominant in the artist, while verbal thinking is dominant in the scientist.

What method of presentation is superior? The question naturally arises here, What method or methods of presentation of materials ought the teacher to employ in order to guarantee the establishment of permanent and trustworthy images in the mind of the learner? Since each individual appears to ideate in accordance with his own peculiar type, it has been widely recommended that the materials of the educative process should be presented to him through the corresponding sense mechanism. Thus, according to this unfortunate notion, a child who is dominantly 'eye-minded' learns best through the eye; the 'ear-minded,' through the ear; and the 'motor-minded,' through exercise of the vocal and other muscles. It has been satisfactorily demonstrated, however, that a person who perceives most accurately through his eyes is as likely as not to translate sense experience memorially into auditory or voco-motor images, and be dependent upon them for reproduction. In a similar way, the auditory perceiver may retain in visual and motor terms, and the motor learner in auditory and visual terms. In other words, the mind appears to have its favorite sense affector, but once the products of sense experience have been admitted to it, they are assimilated and stored up in a form often quite different. It appears from this fact that the determination of a child's characteristic type of imagery will be of little help to the teacher in suggesting what method of presentation should be employed in teaching him.

---

[1] *The Psychology of Learning*, p. 190.

But if knowledge of the dominant image type of a child cannot be put to use in this way with invariable good results, a teacher will find it extremely valuable to discover in what type or types he is weak in order that he may be encouraged to practice ideating in the non-characteristic imagery. Experiments indicate that one who is deficient in any type may voluntarily develop considerable proficiency by practicing its use. Thus, Meumann himself, naturally an auditory-motor verbalist, developed excellent visual memory through persistent practice. Angell recommends[1] the solution of simple geometrical problems by visual images as a means of developing imagery of the visual type; adding, however, that thus far no method has been discovered whereby a type of imagery which is substantially lacking in an individual can be elicited.

The important thing for the teacher to bear in mind is that image types can be trained, and that they should be trained. To this end it is important that as many methods of presentation as possible be employed in the learning process. Visual, auditory, and motor perceptions should be provided for indiscriminately, in the conviction that, in the first place, ability to perceive clearly can be enhanced, and in the second place, that out of these several perceptual experiences each mind will extract and store up in terms of its specific image type the appropriate ideas and meanings. Then, in order to facilitate and develop the ability to transfer images of one type into another, much provision for working over and making varied use of these images should be made through composition and theme writing; verbal descriptions of objects, experiences, processes, etc.; and definite exercise of the visual, auditory, and motor imagination in connection with such subjects as mathematics, nature study, language, drawing, etc.

---

[1] Angell, James R. *Introduction to Psychology*, p. 167.

The improvement of memory. Professor James cites [1] the following treatment prescribed for a case of loss of memory in a person advanced in years:

> The method pursued is to spend two hours daily, one in the morning and one in the evening, in exercising this faculty (memory). The patient is instructed to give the closest attention to all that he learns so that it shall be impressed on his mind clearly. He is asked to recall every evening all the facts and experiences of the day, and again the next morning. Every name heard is written down and impressed on his mind clearly, and an effort made to recall it at intervals. Ten names from among public men are ordered to be committed to memory every week. A verse of poetry is to be learned, also a verse from the Bible, daily. He is asked to remember the number of the page in any book where any interesting fact is recorded. These and other methods are slowly resuscitating a failing memory.

James reacts thus:

> I find it very hard to believe that the memory of the poor old gentleman is a bit better for all this torture except in respect of the particular facts thus wrought into it, and other matters that may have been connected therewithal.

The results of laboratory research into the learning process confirm James's naïve opinion with respect to the nonimprovability of the general faculty of memory. They are also in agreement with his contention that "all improvement of memory consists in the improvement of one's habitual methods" of studying and recording data. Pyle, for example, reports[1] improvement in ability to learn the substance of a textbook in sociology after three months of practice equivalent to 400 per cent, his subjects being able to memorize in fifteen minutes after the practice interval an amount of material that required an hour previous to the practice interval. This rather remarkable improvement depends doubtless, he says, "upon an improvement in methods of getting and organizing the facts, and an increased familiarity with the matter discussed in the book used as material."

---

[1] James, William. *Psychology, Briefer Course*, pp. 297–98.

Improvement specific. As we shall point out more in detail in the next lesson practice in memorization of any sort of material undoubtedly gives increased ability to memorize that particular sort of material. Thus, my own subjects, using French, Spanish, and English vocabularies, commonly find practice in vocabulary learning to facilitate subsequent learning of word lists of equivalent length and degree of difficulty. Dearborn found[2] an increase in efficiency in learning the English equivalents of French or German words of considerably more than 100 per cent in all cases. His subjects learned fifty words a day for from 18 to 22 days. The same investigator achieved similar results in experimenting upon the learning of poetry. Other experimenters have abundantly confirmed the improvability of memory for a series through practice of that series: Winch, using consonants as material;[3] Bolton, using digits;[4] Sleight, using ten different varieties of material;[1] Starch, using mental multiplication;[2] and others.

---

[1] Pyle, W. L. *The Psychology of Learning*, pp. 121–22.

[2] Dearborn, W. F. "Experiments in Learning"; in *Jour. Ed. Psych.*, vol. I.

[3] "Immediate Memory in School Children"; in *Brit. Jour. Psych.* 1904, 1906.

[4] "The Growth of Memory in School Children"; in *Am. Jour. Psych.*, vol. IV. 1891.

Memory in general, it is concluded, cannot be improved through training; ability to memorize specific data can, however, be improved by practice in that datum. The explanation offered is that the subject, through definite and continuous practice, becomes more adept by reason of two facts: in the first place he becomes progressively more familiar with the specific material, and in the second place he improves and refines his methods of procedure. 'Not better memory, but better learning' is the secret of the improvability of one's power to recall through practice.

In addition to these two factors, which are largely mechanical in nature, should be mentioned three others which are more strictly subjective, and to the operation of which is due a good share of a learner's general improvement in retentivity: (1) concentrated attention in impressing the data; (2) thoughtful association; and (3) careful organization of the associates. In so far as the individual observes these conditions of efficient learning he will find his memory improved. We should not lose sight of the fact, however, that instead of any change in the native capacity of his brain cells to retain having taken place, the modification has probably been limited to his method and technique of learning. Thus the elderly gentleman cited by Professor James was instructed to give the "closest attention to all that he learned," to "recall frequently" and to "write down" the names he was to retain. All these proceedings aided his memory through "elaborating the associates." As James remarks: "No amount of culture would seem capable of modifying a man's general retentiveness."

Memory training systems. In recent years, taking advantage of the vexing human tendency to forget and the easy gullibleness of many persons afflicted with poor memorial capacities, pseudo-psychologists calling themselves 'memory experts,' 'memory trainers,' originators of 'memory systems,' etc., have developed a considerable number of special memory training courses which, as Meumann points out, "are guilty of shocking psychological blunders but yield abundant renown to their authors." The popular magazines are often found to carry alluring advertisements of this nature. The mnemonic principle, which underlies most 'courses' of this sort, consists in introducing an artificial auxiliary association which can, theoretically at least, be readily called to mind when wanted and thus bring in the particular datum with which it has been associated, and which it is desired to recall. As employed in the systems of memory training developed by their get-rich-quick promotors, this principle results of course in so over-burdening the mind with a mass of heterogeneous and wholly extraneous associates that, far from training it to retain better, confusion and helplessness become shortly inevitable.

---

[1] "Memory and Formal Training"; in *Brit. Jour. Psych.*, vol. IV.

[2] "Transfer of Training in Arithmetical Operations"; in *Jour. Ed. Psych.*, vol. II.

In the learning process there is scant place for the employment of mnemonics. Coherent and relevant associates, rather than arbitrary and extraneous ones, are the only sort of associations that can be built up economically in the brain cells. Particularly is this the case with logically related material. To substitute an illogical mnemonic device for a natural and logical association of related ideas tends rather to weaken than improve one's memory. The laws of learning and of association cannot be rendered subservient to superimposed artifices.

Simple mnemonic devices. This does not mean, however, that there is no place for simple mnemonic devices to aid in the recall of disconnected facts which cannot be logically associated in the mind. The simple rhyme, beginning "Thirty days hath September . . ." is unquestionably a very valuable and universally employed device for enabling one readily to recall the number of days in a given month. So the doggerel "*i* before *e*, except after *c*, . . ." etc.,

Mnemonic devices, aid in recall of
disconnected facts.

suggests readily the proper spelling of words like receive, reprieve, believe, perceive, etc. The name 'Roy G. Biv' is very easy indeed to remember, and with it the order of colors in the spectrum: red, orange, yellow, green, blue, indigo, violet. The medical student, finding it important to know in order the names of the twelve pairs of cranial nerves, is aided immensely by the well-known doggerel:

On — olfactory
old — optic
Olympus'— oculo-motor
piney — pathetic
tops — tri-facial
a — abducent
Finn — facial
and — auditory
German — glosso-pharyngeal
picked — pneumo-gastric
some — spinal accessory
hops — hypoglossal

Devices similar to these are of considerable value in the economy of memory, since they furnish a rhythmical or other striking series which is learned almost with the first reading, and which spares the learner the considerable effort that would be required to commit the associated datum verbally. Forgetting is likewise all but eliminated, even over a long period of years.

Cramming. It is not unusual in a university to find a considerable number of students who do surprisingly little careful studying from day to day, but who habitually postpone intensive work until the day before examinations begin. Then, often with the aid of a tutor, they endeavor to organize and become masters of a great amount of material which they should presumably have been assimilating day by day throughout the preceding weeks of the semester. For such a method of procedure psychology can have but the strongest condemnation. It violates practically every law of learning save that of recency. At best it enables the learner to hold in mind some of the more significant parts of the material just long enough to regurgitate it during the examination period; at its worst, it introduces associational chaos where order and system should have been provided for, and so hastens the process of forgetting instead of fostering normal retentivity.

The principle of recency is a legitimate ally of the learner, nevertheless, if properly taken advantage of. None of us would care to attempt an important examination without having recently gone over the material upon the knowledge of which we are to be tested, and the student who takes the pains to run through his notebooks and other sources shortly before an examination is acting the part of wisdom. The significant thing is, however, that he shall have thoroughly comprehended and assimilated their contents previously, and shall have frequently turned them over in his mind. By thus observing all the other laws and principles of learning, from day to day, he will be in a position to enjoy the full benefits of the consummating law of recency. As Pyle so aptly expresses it:[1] "The cramming process is not effective for lasting memory unless there has previously been learning of the parts in detail. A bird's-eye view of a lot of material is profitable provided we have previously had a microscopic view."

Peculiarities of association. We have learned that memory operates in accordance with definite laws and principles of learning and association, and that only in accordance with the working of these principles can one idea follow another into consciousness. While in general such is the case, we should bear in mind that, either because psychology has not yet been able to formulate all the laws of association, or because the actual operation of those known cannot in all cases be discerned, it is impossible to account introspectively for the entrance of every idea into consciousness. Very often we experience the 'breaking in' upon our present connected train of thought of some wholly unrelated and irrelevant idea. Such usurpers of focal consciousness are commonly known as 'free-rising' ideas. Some moments since, for example, as I sat in my study writing, there flashed into my consciousness the memory of an amusing letter which I received yesterday, and I found the corners of my mouth relaxing into a spon-

---

[1] *The Psychology of Learning*, p. 154.

[illegible] unknown cause.

taneous smile. There was not the slightest apparent connection between what I was thinking at that focal moment and the idea which burst unheralded in upon my thoughts.

Meumann distinguishes[1] four distinct causes for the emergence of such free-rising ideas; namely: (1) perseveration; (2) persistence; (3) iteration; and (4) automatization. The first of these, perseveration, means the return of an idea that had shortly before been in consciousness, and may be illustrated by the fact that the 'amusing letter idea' has been intermittently coming back into my mind for the past ten minutes. The second cause, persistence, means the tendency of our ideas to become repetitively persistent when we are too fatigued to react in a discriminating fashion, and may be illustrated by the tendency of a tired subject in the laboratory to react repeatedly in a stereotyped form of verbal response which cannot be interpreted as the product of normal vigorous association of ideas. The third cause of free-rising ideas, iteration, is assigned to the tendency of voco-motor images to intrude bothersomely upon our train of thought, and may be illustrated by the repeated 'running through the mind' of a familiar melody, rhyme, or single words. The fourth, automatization, is described as the result of "the frequent execution of activities which thereby become completely automatized," and may be illustrated by the tendency for one who has just come from the French into the German classroom to introduce a French idiom in the translation of an English sentence into German.

Meumann summarizes[2] thus the phenomenon of free-rising ideas:

> What particular idea shall appear in consciousness in any particular case is a matter which is not determined solely by the associative connections possessed by the ideas which are present at the moment; quite as much influence is exerted by the general

---

[1] *The Psychology of Learning*, pp. 25 ff.

[2] *Ibid.*, p. 22.

condition of the individual, his freshness or fatigue, the fact that he is well-disposed or ill-disposed, the total group of impressions and ideas which are clearly or obscurely present to his consciousness, his feelings, and everything else that may be designated as his conscious constellation. . . . This embraces all the feelings, efforts, ideas, impressions, and the like . . . as well as the general condition of the individual.

Further pedagogical applications of the psychology of memory

Children do not have better memories than adults. It is rather commonly — though quite erroneously — supposed that children are capable of learning more rapidly and efficiently than are adults. The reverse is rather the case. Children employ naïve and uneconomical methods of impressing the data, as well as doubtful methods of associating and assimilating them. Consequently, the memorial efficiency of children is appreciably less than that of mature persons. Pentschew, a Swiss investigator, found that nine-year-old school children of Zürich were incapable of remembering more than fourteen nonsense syllables, and that they fatigued very rapidly. Unpracticed adults, on the other hand, were able to learn lists at least twice as long, and practiced adults did still better. In immediate reproduction Meumann found[1] children ten and twelve years of age able to retain at dictation an average of four letters; and at thirteen to fourteen years, five to six letters; while practiced adults retained thirteen to fourteen.

Investigators of the relative learning and memorial capacity of children and adults are in fundamental agreement that the former possess a narrower attention range, and that they are inferior in both rote and logical learning capacity to the latter. They are also agreed that improvement in learning and memorial abilities is fairly uniform up to approximately the fourteenth year, when it reaches a tolerably constant level that is raised thereafter but little if any throughout the adolescent period. In certain func-

[1] *Op. cit.*, p. 321.

tions, as for example, reproduction of digits, improvement has been demonstrated to occur up to the eighteenth or nineteenth years. In general, it may be safely said that children's immediate memories are conspicuously inferior to those of persons fifteen years of age and older. As Whipple remarks:[1] ". . . Memory appears, when measured by the first reproduction, to be at its best near puberty." Whether delayed reproductions (i.e., retentivity) are similarly inferior cannot yet be answered with certainty, although there is good evidence that the retentivity of younger subjects is as high as that of adults.

Children's memorial efficiency increases more rapidly in the laboratory than under schoolroom conditions. Meumann is at some pains to point out that notwithstanding its possibilities of development, memorial efficiency improves far less during school age than it is capable of doing, and cites in support of this contention the fact that in his own laboratory children frequently show a tenfold increase in retentivity in a very short time. In the schoolroom, he says:[2]

> . . . The will of the child is not directed toward an increase of formal memorial efficiency itself, but is directed in one-sided fashion toward an acquisition of certain definite data. This explains why, notwithstanding his daily training in memory and in immediate reproduction, the child's progress in these two functions appears to be conditioned solely by his increase in age, and is entirely disproportionate to the actual use which is meanwhile being made of his memory. In our laboratory experiments, on the other hand, the intention to improve one's memory is awakened from the first moment onward.

Meumann is perhaps inclined to look upon formal memory training with more favor than the results of many recent investigations would appear to warrant. He is, however, giving expression to a very significant fact when he states the importance of enlisting both the will and the interest of the child in the task he is to perform. It is unfortunate that more of the laboratory spirit of enthusiasm and confidence cannot be transplanted to the study hall, library, and classroom. To this end the importance of good motivation, a clearly envisaged goal, and proper methods of study cannot be overemphasized.

---

[1] Whipple, G. M. *Manual of Mental and Physical Tests*, p. 400.

[2] *The Psychology of Learning*, p. 363.

Danger of too many data being presented at once. In the interests of economical learning it is found to be extremely unwise and even disastrous to present too many impressions at one time. Careful laboratory experiments have demonstrated the following principle to be true: The number of repetitions required to learn a datum is increased enormously as its length is extended beyond one's memory span. Ebbinghaus was able [1] to commit to memory a list of seven syllables by one reading, but when he increased the list to twelve, he found it necessary to repeat the series sixteen or more times, and when he still further increased it to twenty-four, he found he must repeat it forty-four times. Lyon, who has done yeoman work in this field, reports [2] increases in number of readings required to memorize progressively longer selections of prose and poetry as shown in Table X.

It will be noted that the number of repetitions does not, according to Lyon's results, increase in precisely the same ratio as the length, 800 words requiring 34 readings, and 1000 only 33; 1500 requiring 40, and 2000 only 35, etc. Exactly the reason for this is not clear. The important thing, however, is that *in general* the more a datum is extended the more difficult it becomes to learn it. From the viewpoint of teaching, this means that long assignments, lectures, etc., are unwise unless a good part of them is concerned with organizing, illustrating, and elaborating the material presented.

Learning and memorizing not synonymous. Students

---

[1] Ebbinghaus, H. *Memory.* (Tr. by Ruger, 1913.)

[2] Lyon, D. O. "The Relation of Quickness of Learning to Retentiveness"; in *Archives of Psychology.* 1916.

TABLE X. SHOWING NUMBER OF READINGS REQUIRED AT ONE SITTING TO COMMIT VARYING LENGTHS OF PROSE AND POETRY (AFTER LYON)

PROSE		POETRY	
No. words	No. repetitions	No. stanzas	No. repetitions
25	1	1	1
50	9	2	3
100	23	4	7
200	24	5	8
400	28	6	12
800	34	8	11
1000	33	10	18
2000	40	12	16
3000	35	18	22
4000	38	21	24
5000	65	25	20
7000	59	35	24
10000	84	40	22
15000	73	50	25
		75	30
		100	33

not infrequently have the mistaken notion that to master a lesson is to commit it verbally to memory. McMurry tells of a very lazy student whom he once had in history. His ambition temporarily aroused by the possession of a brand-new book, however, he started off finely when called upon in recitation the next day. Soon he stopped, in the middle of a sentence, and sat down, saying he had got no further. In some surprise McMurry glanced at the book and discovered he had been repeating the text *verbatim*, the last word uttered being the last word on the first page! The writer's experience at one time as a tutor of high-school

[illegible]

pupils was not unlike McMurry's. One student in particular habitually committed to memory the translation of English-French and French-English sentences before the recitation hour, and when called upon to reproduce them in the other language did so glibly, and without thought. It is the testimony of teachers everywhere that students, before they are taught better, tend to memorize their lessons rather than to study them thoughtfully and critically.

McMurry assigns[1] three reasons for the prominence given by students to memorization, as follows: (1) the fact that memorizing is easier than real thinking, and it is human nature to do the easiest thing; (2) the still somewhat common belief that the memory is strengthened through its exercise; and (3) the belief that memorizing normally precedes rather than follows thinking, it being supposed that "the raw materials for reflection must be gotten into our possession before we attempt to reflect upon them." All three of these reasons can of course be dismissed almost without serious comment. There is no excuse for that intellectual laziness which rests content with doing the easiest and most superficial thing; to hold that exercise strengthens memory is open to question in the light of the results of experimentation; and to suppose that once a datum has been memorized its possessor is thereafter prone to give it much serious reflective thought is not warranted by the experience of the classroom teacher.

How then are we to reduce to the minimum the amount of actual mechanical *memorizing* the learner shall resort to in the daily learning process, and at the same time raise to the maximum the amount of concentrated, reflective *thinking* that he shall substitute for it? McMurry prescribes more motivation, the abandonment of attempts to strengthen the general power of memory, and improving the method of learning as the three means whereby this may happily be brought to pass. So far as the student himself is concerned the third — improving the method of learning

1. More motivation
2. Abandon —
3. Improve way of learning

---

[1] McMurry, F. M. *How to Study*, p. 162 ff.

Analysis! Memory to learning

— is the important factor. Thoughtful impression of the data through properly distributed repetitions, with full analytic attention; careful and logical association, with systematic organization of the associates — these are the essential things in all learning. Memorizing under such conditions becomes little more than an incidental concomitant which takes care of itself quite largely. Pupils of all ages should be imbued with this ideal of study, and teachers ought so to make the assignments of work, and so manage the study and recitation periods, that a premium is placed upon thinking and using facts rather than memorizing and reproducing them verbatim.

QUESTIONS AND PROBLEMS

1. Methods of determining ideational types.
2. Writing as an aid to learning.
3. Memory systems.
4. Amnesias.
5. Number forms and chromæsthesias.
6. Legitimate place of cramming.

SELECTED REFERENCES

1. Breese, B. B. *Psychology*, chapter 10.
2. Freeman, F. N. *How Children Learn*, chapter 10.
3. Meumann, E. (Tr. by Baird.) *The Psychology of Learning*, chapter 5.
4. Pyle, W. H. *The Psychology of Learning*, chapter 7.

PART III

THE RESULTS OF LEARNING

It is what after — long
~~—~~ training in one subject
~~tag~~ transfers its training
to another subject

2d Case

"Training ideas
Respect.
interspersed with [illegible] in the
[illegible]

Problem: Will the formation of one habit either help or hinder in the formation of another?

LESSON 16

THE TRANSFERENCE OF TRAINING

EXPERIMENT:

32. It is suggested that an experiment, similar to the one described in the lesson (see pp. 360 ff), be undertaken by the class in the usual laboratory groups. It will be necessary for the instructor to prepare the several tests beforehand, for both the practice series and the initial and final test series. With a little care in working out the details he may assign to several students the task of compiling the foreign-language vocabularies as well as the other tests to be employed, being careful to arrange the experiment subsequently so that no *S* will be assigned to learn data which he himself has compiled.

The class should be divided into two general sections, one to act as the practice group, the other as the control group. In making the division of the students into these two sections, the instructor should not of course go at it alphabetically, but should, on the basis of class standing, intelligence tests, and other experimental results which he may have in his possession, balance the two groups as accurately as possible, so that the average learning capacity represented in the one will be approximately the equivalent of that represented in the others. Accurate records are to be kept by each *E*, and the final results are to be tabulated in form suitable to indicate the outcome of the experiment. With the help of the instructor such conclusions as seem to be warranted should be drawn, and the entire experiment written up in full in the notebook. Planned systematically and carefully conducted, this experiment should prove an excellent one to demonstrate to the student something of the technique of scientific experimentation as employed in the psychological laboratory.

The problem stated. One of the outstanding questions confronting the educationist to-day concerns itself with the problem of mental transfer. Does the training which one receives in one situation carry over into other situations? Concretely, will practice in mathematical reasoning predispose one to reason better in the field of political economy? Will practice in memorizing nonsense syllables facilitate memorizing of words, prose or verse selections, or other nonsense syllables? Will practice in the discriminating of shades of blue increase one's ability to distinguish shades of red, or white, or yellow? Is the subject who is practiced in sight-typewriting enabled thereby to learn touch typewriting more readily? Will the ideal of neatness insisted upon in the preparation of arithmetic papers influence the preparation of language and spelling papers? In fine, is the effect of practice specifically confined to improvement in the situation practiced, or is it to some extent general, spreading to other situations not thus specifically practiced?

A recent writer on the subject of transfer puts it thus[1] concretely:

> What would be the effect of four years' earnest effort to excel in classical languages and mathematics upon one's ability to master the intricacies of banking, or upon one's persistence and doggedness in the face of any other complex problem? What is the effect of four years' work in the high school and four years in the university upon the probability that one will continue to master new problems afterwards — that is, upon the probability that life will be a career instead of merely the holding down of a job? What would be the effect of writing a first class doctor's dissertation, say on education, upon one's ability to organize the advertising department of a great industry? To what extent will prolonged and intensive mental effort tend to inure one to the onerousness of mental effort? Does extensive experimentation in finding solutions of difficult problems tend to make one more enterprising and persistent in casting about for the solutions of other problems?

The practical importance of the problem for education. Upon the answer given to these questions rests the whole fundamental theory of education. If they are correctly answered in the negative, then it is evident that training possesses no transfer value; specific outcome results from specific practice: we train what we train. Practice in mathematics is of non-effect in political economy; memorizing one type of datum enables one to retain it, but does not make memorizing of other data easier; practice in discriminating shades of blue renders one skilled in that particular thing, but does not add to his ability to distinguish shades of green or red; ideals of neatness in arithmetic papers do not operate in the preparation of papers in language or spelling. If, on the other hand, these questions are correctly answered in the affirmative, then it follows that we train not only what we train, but also something else; general results accrue from specific practice. As the heart is trained by exercising the leg muscles, so linguistic abilities are trained by exercising the mathematical faculties, 'word memory' by exercising 'number memory,' etc.

---

[1] Lennes, N. J. "A Mathematician on the Present Status of the Formal Discipline Controversy"; in *School and Society*, vol. XVII, no. 421.

If the doctrine of transfer is tenable, it does not make so much difference what is taught: mathematics will possess disciplinary value for those who are never to make any more extended use of it than is involved in running a family budget or in keeping a check-book balanced. They will be better artists, better business men, better citizens, through the beneficent influence exerted over them by systematic study of algebra and higher mathematics. If the doctrine, on the other hand, is untenable, then the highest importance at once attaches to the content of the curriculum. Latin and foreign languages and advanced arithmetic must go by the board, save only in the case of those who are to specialize in some form of life-work in which familiarity with these subjects is essential to progressive achievement. The premium which has so long rested upon these subjects as developers of strong, vigorous intellects *in general* will have to be removed, and popularization be made of the idea 'Latin for Latin's sake'; 'languages for languages' sake'; 'Arithmetic for arithmetic's sake,' etc. Intellectual giants being impossible to train up, we shall perforce need to cast about us to determine exactly what different kinds of knowledge are most essential and then proceed to build them up, compartment by compartment, in the learners' brain cells. It is because he so appreciates the profound significance of the whole question of formal discipline that Professor Whipple feels justified in referring [1] to it as "the central problem of educational psychology." Professor Starch, in similar vein, avers [2] that "... the ultimate values of education as a whole depend primarily upon our attitude toward the problem of mental discipline and transference of training." Professor Judd, likewise, considers [3] it the "great problem of high school education."

The formal discipline controversy. Whenever in the history of education certain curricular subjects have been generally thought to be somewhat antiquated, and out of step with the social needs and ideals, the conservative schoolmen reply to the attack of the more practical-minded that the subjects under fire possess much general disciplinary value. They build up within the minds of the pupils, so it is argued, such indispensable habits as, for example, concentration, observation, analysis, good judgment, critical attitudes, etc., and these are more useful than any amount of mere information about certain specific facts. Among the subjects which have been defended from this point of view belong especially the classic languages, mathematics, and laboratory science. Secondary and higher institutions of learning for this reason largely have prescribed for all students within their doors these and other 'disciplinary' subjects of study.

Previous to the time of Herbart, psychologists were committed to the notion that the mind is made up of a number of abstract mental powers which were called 'faculties.' Thus, there was the faculty of judgment, of reasoning, of memory, of imagination, of will, of emotion, etc. The mind was not unlike a series of pigeon-holes, or hermetically sealed compartments, each one of which became the repository of its appropriate type of material. Obviously such a conception of the mind lent plausibility to the theory of formal discipline. The best way to improve the judgment faculty is by judging; the best way to improve the reasoning faculty is by reasoning; the best way to improve the memory is by memorizing, etc. Classical languages and mathematics offer ideal subject-matter upon which thus to exercise these faculties. Laboratory science is an excellent means of developing general habits of precision and conservative thinking.

---

[1] In his preface to Professor H. O. Rugg's *Experimental Determination of Mental Discipline in School Studies.*

[2] Starch, D. *Educational Psychology,* p. 191.

[3] Judd, C. H. "On Scientific Study of High School Problems"; in *School Review.* 1910.

The newer conceptions. The newer psychology has materially changed this conception of mind as a composite of abstract energies. Herbart led the way by dismissing the idea of a division of mental power into faculties — save as a mechanical means of description of various phases of the mind's activities — and conceiving mind not as made up of perceptive, imaginative, rational, and volitional powers, but rather of groups of specialized ideas gleaned from past experience. Every person is discovered to possess widely varying abilities in the same 'faculty.' Henderson puts it well [1] in the following paragraph:

[illegible]

> . . . It has been found that memory is a somewhat specialized power. Certain persons have a better memory for visual experience, others for auditory experience, etc. Moreover, it is recognized that one's powers of discrimination are a function of what he knows. The microscopist may see with his glass significant structures that to the untrained eye are practically invisible, since the attention cannot single them out. The same expert might show a lamentable lack of ability to note the essential features in the style of dress worn by a woman. We see what we expect to see. So, too, one's memory is so largely dependent upon association that his ability will lie especially in those fields

---

[1] In article on "Formal Discipline," in *Monroe's Cyclopedia of Education,* vol. II.

[illegible] ¶7 1. Contents 2. Procedure

in which he already possesses a rich fund of material with which to associate the new fact. In a sense, one's experience, what he has assimilated and therefore remembers and knows, determines what he shall see and remember, and how he shall judge and will

According to the newer conceptions of psychology the mind is a functional unit. Instead of the 'compartment' idea, we have the 'mosaic' idea. Memory does not exist as a separate faculty insulated from attention, for example; it is a phase of conscious behavior, of which attention is another and supplementary phase. In like manner, judgment, reasoning, and will are all dynamic complements, and one cannot make use of any one of them without involving all the others. Conscious life, in other words, does not proceed by disconnected action, now of this faculty, now of that; but rather it proceeds by harmonious neural discharge which at one moment is memorial in nature; at another, observational; at another, rational; at still another, reflective, etc., etc. Suppose, for example, a student is struggling with a hard bit of Latin prose. He must successively or simultaneously use will, attention, memory, judgment, imagination, reasoning, observation, and whatever other 'faculties' he possesses. To contend that he is training any one of them more than another is probably not in accord with the actualities.

With the decay of the older psychological conception of the 'faculties' there has arisen a fresh onslaught upon the classical languages and mathematics. Since memory and reason do not exist as independent entities in the mind, wherefore continue to require students in the secondary and higher schools to study those subjects, which have always admittedly aimed at training them? To this question the apologists have responded something after this fashion: The old so-called disciplinary subjects are the best means known to develop in students good mental habits of concentration, judgment, reasoning, and the like. If now it can be established, as is claimed, that these highly desirable mental habits can 'carry over' from the Latin and the

[illegible] to extent that [illegible]
are common elements.

Greek and the Euclid from which they sprung to other subjects and to other life situations, then we shall have to admit that the study of languages and mathematics results in building up certain highly desirable general habits, although it is yet to be demonstrated that those same general habits cannot be built up as economically in connection with subject-matter more permanently and universally valuable to people generally.

Let us turn to the experiments in order to find out to what extent transference of habits from one field to another has been demonstrated to occur.

Experimental investigations of the matter of transference of training. In keeping with its relative importance as an educational problem, the matter of mental transfer has inspired probably more careful experimentation than any other educational subject in recent years. Scores and very probably hundreds of investigations of one kind or another have been undertaken by teachers and laboratory men, some of them possessing definite preconceived notions on the subject, most of them anxious to get really sound results. The general weakness of most of the experiments reported has been the fact that they have been performed upon adults in university laboratories, and not upon children under actual schoolroom conditions. Another damaging weakness is that only a few subjects are ordinarily used for these experiments. The fact that the tests are made under carefully controlled conditions, however, goes far toward compensating for the paucity in numbers of the subjects, though it is open to some question whether results got from adults afford a satisfactory basis on which to draw comprehensive conclusions concerning transfer of habits in children, in whom all habits are still in process of formation. In the following paragraphs we shall enumerate briefly several of the more important experimental investigations.

1. Coover and Angell. Among the earlier psychological experiments upon the general problem of transference were those by Coover and Angell, who investigated[1] the transfer of practice effects in sound to light discriminations, and in card-sorting to typewriting. In the first experiment, four subjects were trained in discriminating sound intensities, each subject making forty judgments on each of seventeen days' training. The end tests used were tests of discrimination of grays, one hundred five judgments being made on each of three separate days before and after the practice tests. Control subjects were employed as a check, and it was found that three of the four subjects made a residual gain in gray discrimination of seven per cent, five per cent, and fifteen per cent, respectively, while the fourth subject actually lost. The experimenters concluded that the gain recorded was due "in great part to habituation and to a more economic adaptation of attention, i.e., improvement was general rather than specific in character." In their second experiment four subjects were trained for four days in card-sorting, a total of four thousand cards being handled by each. The end tests used were typewriter reactions, six hundred per day for five days comprising the first end test, and six hundred per day for three days the second end test. Improvement was shown as a result of the practice in card-sorting, "the general condition common to both sorting and typing being the habit of stripping the essential process of unnecessary and complicating accessories"; i.e., the habit of more direct and immediate reaction to the stimulus which obviously results in improved performance.

2. Thorndike and Woodworth. Two other experimenters, Thorndike and Woodworth, achieved[2] somewhat different results. They used magnitudes in their tests of improvement through practice, such as lines of various length, areas of different sizes, and weights of several amounts. The practice series consisted in estimating lengths, sizes, and not-[illegible]

---

[1] Coover, J. E., and Angell, Frank. "General Practice Effect of Special Exercise"; in *American Journal of Psychology*, vol. 18, pp. 328–40. 1907.

[2] Thorndike, E. L., and Woodworth, R. S. "Improvement in Mental Functions"; in *Psychological Review*, vol. VIII.

weights; also in perceiving words containing certain given combinations of letters. Four and six subjects performed the several experiments, which were designed to test "the influence of improvement in a function on other functions closely allied to it." They concluded that "there is no reason to suppose that any general change occurs corresponding to the words 'improvement of the attention,' or 'of the power of observation,' or 'of accuracy'"; but that "improvement in any single mental function rarely brings about equal improvement in any other function, no matter how similar, for the working of every mental function-group is conditioned by the nature of the data in each particular case." Finally, they concluded, "the general consideration of the cases of retention or of loss of practice effect seems to make it likely that spread of practice occurs only where identical elements are concerned in the influencing and influenced functions."

3. Starch investigated[1] the transfer of training in arithmetical operations, using eight college students as subjects. The end tests consisted of six tests in arithmetic and two in immediate auditory memory span. The practice tests comprised fourteen days' practice in mental multiplication. A control group of seven other students acted as check. In the final end test, Starch found the practiced group showed from twenty to forty per cent more improvement in the arithmetical tests than the control group, but that in memory span there was almost no gain or loss. He concluded that the improvement in the former function was due to "identical elements acquired in the training series."

4. Briggs studied[2] the disciplinary effects of the study of formal grammar. A total of fifty-four tests were given to children in the Horace Mann School; they were tests to discover ability to see likenesses and differences; to judge;

---

[1] Starch, D. "Transfer of Training in Arithmetical Operations"; in *Journal of Educational Psychology*, vol. VI. 1911.

[2] Briggs, T. H. "Formal English Grammar as a Discipline"; in *Teachers College Record*, vol. XIV. 1913.

to amend when faulty; to apply a definition; to formulate a rule; to reason arithmetically; to reason syllogistically; to follow directions, etc. Three periods per week for six months were devoted to these tests. The practice test comprised drill in formal grammar, which was continued intensively for three months. From the final end test results, Briggs concluded that "these particular children, after the amount of formal grammar that they had, do not, as measured by the means employed, show in any of the abilities tested improvement that may be attributed to their training in formal grammar."

5. *Bennett*, working with children of the Speyer School, investigated[1] the transfer value of special practice in discrimination of different saturations of blue to other sense powers. His subjects were sixteen eleven-year-old children. Preliminary and final end tests were the discrimination of different mixtures of red and white, yellow and green, orange and black, and of different auditory pitches. The practice series consisted of a half-hour period, twice a week, spent in judging various saturations of blue on the color mixer. Bennett's results showed not only that ability to discriminate different saturations of blue increased during the training series, but that there was also marked improvement in the final tests in ability to discriminate the mixtures of red and white, yellow and green, and orange and black. In pitch discrimination there was also distinct improvement, though it was not nearly so marked as in color discrimination. He concluded that "training in the discrimination of some colors is highly effective in the discrimination of others, much less so with tones."

6. *Ruediger*, using as his subjects pupils in the seventh grade, endeavored[2] to ascertain whether and to what extent the ideal of neatness brought out in connection with one

---

[1] Bennett, C. J. C. "Formal Discipline"; in *Teachers College Record*. 1907.

[2] Ruediger, W. C. "The Indirect Improvement of Mental Functions through Ideals"; in *Educational Review*, vol. 36. 1908.

school subject functions in the other subjects. Eighty-three children in three schools, each in a different town, participated in the experiment. In the written work required to be handed in in one subject he insisted specifically upon neatness. He talked with the children about the importance and value of attractive papers, and held up before them constantly a lofty ideal of neatness, being careful, however, not to refer to this ideal in connection with any other subject except the one concerned. One or more papers a week for eight weeks were collected in each of three or more subjects. As the experiment progressed, he found that there was a noticeable improvement in the appearance of all the papers, although the greatest gain was undeniably in the subject in which the neatness ideal had been emphasized. He concluded that neatness "evidently made conscious as an ideal or aim in connection with one school subject does function in other school subjects," the transfer being due, in his opinion, to "identity of aim."

7. *Winch* investigated[1] transfer of memory in London school children. The practice test used for one group consisted of memorizing poetry, and the transfer to memory for prose material in geography and history was determined. In one series of experiments, the practiced group was found to excel the control group by ten per cent, and in another series, by five per cent. In still another experiment, rote memorizing of sense and nonsense materials represented the practice series, and the transference of the results of this practice to memorizing of logical materials was found to be positive, but very slight, the practiced group excelling the control group by only about 3.3 per cent.

8. *Sleight*, another English investigator, trained[2] three different groups, one in learning poetry, one in learning tables, and another in memorizing prose. Initial and final

---

[1] Winch, W. H. "The Transfer of Improvement in Memory in School Children"; in *British Journal of Psychology*, vols. I, II, III.

[2] Sleight, W. G. "Memory and Formal Discipline"; in *British Journal of Psychology*, vol. IV. 1911.

end tests were given the groups in ten different aspects of memorizing: dates, nonsense syllables, poetry, prose, letters, etc. Control groups were used in all cases.

He conducted two independent experiments, one with students eighteen and nineteen years old, another with school children between eleven and twelve years of age. Sleight's results with both the elementary and advanced subjects showed no general improvement of the practice groups over the control groups. Practice in poetry and tables did carry over to learning nonsense syllables and dates; practice in prose substance improved memory for prose substance, but not for poetry or tables. In three of the final end tests the practiced group fell below their records for the first end tests. This investigator concluded that the effects of practice are transferred only when common elements exist in both tests.

The technique of transfer experiments. In order that we may comprehend the full significance of experimentation in the field of transference of training, it will be helpful for us to pause for a moment to consider the method of setting up and carrying out an experiment of this sort. The materials consist of a practice series, and two sets of end tests. Two groups of subjects are necessary, a practice group, and an unpracticed or control group. At the beginning of the experiment the first end test — say, a list of twenty nonsense syllables and sixteen lines of poetry — is given to both groups of subjects, and a careful record is made of the time required by each individual in both groups to memorize the data. The practice group thereupon begins its periodic training series — say, sixteen lines of poetry daily for ten days. The control group, in the meantime, undergoes no training whatever. At the end of the training series, the second, or final, end test — another list of twenty nonsense syllables and sixteen more lines of poetry of identical difficulty with the lines used in the first end test — is given to both the practice and the control group, and again a record is taken of the exact time required by each individual in both groups to memorize the data. It is then possible by comparing the two groups to determine whether practice in learning poetry daily for ten days has resulted in a gain in ability to learn nonsense syllables and lines of poetry, and whether the amount of gain thus made is more than that shown in those individuals who have had no intervening practice. In other words, if there has been any transfer or 'spread' of the results of practice, there will remain a residual gain in favor of the practice group over and above any gain which the control group may chance to have recorded in the second end test over the first end test.

We may indicate the steps in transfer experimentation thus:

Table XI. Practice and Control Groups

A Practice Group	*B* Control Group
1. First end test	1. First end test
2. Practice or training series	2. (step omitted)
3. Second or final end test	3. Second or final end test
4. Gain (or loss) in final end test	4. Gain (or loss) in final end test
Residual gain (i.e., net gain of *A* group over gain of *B* group.)	

It is obvious, of course, that the greater the variety of mental functions called for in the end tests (memory for words, reasoning, observation, discrimination, etc.) the greater the possibilities of testing any 'spread' of the effects of practice of a given training series to different phases of mental behavior. Sleight, for example, practiced his observers in learning poetry, tables, and prose substance, and then tested the transfer effects of such practice upon learning dates, nonsense syllables, poetry, prose, and letters. It is conceivable that, were the scope of mental functions tested inclusive enough, and our methods of conducting the experiments refined enough, we should be able to discover exactly what, if any, transfer of training occurs in the case of any individual as between any two given performances.

A transfer experiment. The experiment to be described in the following paragraphs was performed under the author's direction, by two groups of mature teachers and teachers-in-training. The practice group comprised six fourth-year normal school students, all but one of whom had had several years' experience in teaching. The control group was composed of seven students of similar scholastic abilities, but who had had very limited experience in actual teaching. Every subject in both groups was a mature and painstaking individual who had had definite laboratory training in psychology.

The end tests were six in number, as follows: (1) a hard French vocabulary (twenty words); (2) a hard Italian vocabulary (twenty words); (3) a hard English vocabulary (twenty words); (4) twenty-four four-place arithmetical sums; (5) an 'opposites' test; and (6) a logical memory test. The practice test was a series of hard Spanish vocabularies of twenty words each. One of these vocabularies was practiced daily, for eight days, up to the point of immediate reproduction. Careful records of the time required in both end tests and practice tests were kept. The end tests were given to both groups of subjects under identical conditions, and at the same time of day. The daily Spanish vocabulary was learned by each individual in the practice group, at the same hour, on eight successive days. On the two days immediately preceding the eight practice days, the first end tests were given to both groups; and on the two days immediately succeeding, the second end tests were given to both groups. Thus careful attempts were made to rule out all unusual and complicating situations which might in any way modify the results.

The first end tests were as follows:

(1) *French vocabulary*

gréement	rigging
empuantissement	stench

ternissure	tarnishing
bocage	thicket
vrille	tendril
puvaise	bug
dardillon	bard
menottes	handcuffs
appeau	bird-call
sillon	furrow
picoterie	teasing
jocrisse	simpleton
morfondure	catarrh
courroux	wrath
gueusaille	rabble
brimborions	toys
vetille	trifle
echantillon	pattern
maringouin	mosquito
cribration	sifting
cambrure	bending
lacune	interruption
garissement	draining
badauderie	illness

(2) *Italian vocabulary*

cicogna	stork
tafferuglio	uproar
veduta	prospect
lentiggine	freckle
zampillo	water spout
poggiuolo	verandah
ergastolo	dungeon
oziosita	laziness
trattenimiento	amusement
sporcheria	filth
giovinotto	youngster
perocche	because
cortile	yard
limaccioso	muddy
contadino	peasant
empetiggine	ringworm
gozzovigliare	revel
minaccia	threat

fringuello	chaffing
chincchrlaia	nonsense

(3) *English vocabulary*

limpet	shellfish
scarabæid	beetle
paronomasia	word play
minatory	threatening
francolin	partridge
glabrous	smooth-skinned
gurnard	sea fish
zirconium	metal
granadilla	a flower
stactometer	liquid dropper
lithophyte	polyp
viscacha	rodent
coetaneous	contemporary
stannary	tin mine
thylacine	wolf
phlebotomy	blood-letting
nenuphar	water-lily
titubation	fidgetiness
kilderkin	cask
cartulary	register

(4) *Arithmetical sums*

8659	7635	4768	8793	8694	5674	6920	4769
5678	9802	6758	5692	4573	5603	8572	6784
6584	9856	9748	5874	5685	8795	6758	8795
8794	9846	7386	8793	3869	8794	8769	6749

8675	7957	8674	6849	6748	9684	8674	6749
5687	9785	9674	5674	7859	7894	6875	9685
9756	9785	7868	7858	6767	8786	8695	6748
3467	8769	7859	7859	7958	6777	6685	5767

6875	6857	6879	6879	8675	6758	9785	7846
6878	9857	9867	6768	7857	6849	7856	7868
8795	6776	7887	7878	7859	6784	6738	6758
6758	7878	8788	7878	9899	7857	8674	5647

(5) *'Opposites' test*

Directions: Look at the first word on each line, think what word in the list at the right of it means the opposite thing. Then draw a line under it.

Thus: good . . . . bad, poor, happy, glad, cheerful

wet	cold, dry, snow, warm, dew
in	under, outside, out, outer, exit
hill	plain, mountain, plateau, slope, valley
allow	forbid, permit, oppose, rebel, support
expand	decrease, enlarge, contract, burst, swell
former	first, last, earlier, later, latter
shy	timid, cautious, brave, bold, courageous
delicate	fragile, tender, tough, sour, steel
cheerful	melancholy, optimistic, querulous, sorry, sanguine
accept	oppose, reject, permit, take, forbid
concave	inverse, reverse, oval, convex, curved
lax	easy, legal, hard, changeless, strict
debase	exalt, raise, perfect, improve, increase
dissension	happiness, pleasure, eagerness, friendship, harmony
repress	spend, allow, express, say, help
amenable	strong, intractable, hard, enemy, hostile
prevent	help, permit, passive, neutral, disinterested
fallacy	right, good, verity, righteous, perfection
specific	general, everlasting, average, inclusive, complete
pompous	humidity, humble, quiet, passive, hermit
accumulate	donate, subscribe, generous, dissipate, kind
apathy	wish, prayer, fervor, ideal, longing
effeminate	soldier, brave, hero, unafraid, virile
benign	gloom, forbidding, darkness, unimpressive, cold
abjure	oath, affirm, swear, accept, declare

(6) *Logical memory test*

For this test, the story used in the *Otis Group Intelligence Test, Scale B*, was used. The story begins: "Once upon a time in a small village there lived two shepherds . . ." For ease and rapidity in scoring, the story was previously divided off into a total of ninety-nine separate ideas, and the score of each subject was subsequently computed on the basis of the percentage of the entire ninety-nine ideas which she recalled correctly immediately after auditory presentation of the story.

The practice series consisted of Spanish vocabularies of twenty words each. Only the first two are here presented:

Practice test I		*Practice test II*	
tallador	engraver	zozobra	uneasiness
pulgar	thumb	yunque	anvil
tropiezo	obstacle	trigueño	swarthy
quebrado	fraction	sabueso	hound
aparceria	partnership	bobatico	silly
niñez	childhood	noneria	dotage
tabano	hornet	supercheria	fraud
zapatero	cobbler	remolino	whirlwind
quinon	dividend	empachoso	embarrassing
ladronicio	theft	abastecimiento	provisions
apretura	crowd	soponcio	grief
farfantonada	boast	trituracion	pulverization
pulgada	inch	repenton	event
zaguan	porch	pujanza	strength
hierro	iron	caserio	village
apreton	pressure	pedaco	bit
zipizape	scuffle	xaurado	helpless
roneria	cunning	estrambote	burden
nimiedad	excess	abejarron	bumble-bee
espejo	mirror	castaña	chestnut

The final end test comprised six tasks of identical nature with those of the first end test, as follows:

(*1*) ***French vocabulary***

acariatre	peevish
vergogne	shame
saumatre	brackish
coriace	tough
aiguiser	whet
billevesée	humbug
maussadement	sulky
fretillement	frisking
feuilletoniste	novelist
polisson	blackguard
orvietan	quackery
decelement	disclosing

pendard	rogue
oisiveté	inaction
mouchard	spy
galimatias	nonsense
tuyère	blast pipe
ribambelle	array
ravigoter	revive
tabletterie	toys

(2) *Italian vocabulary*

mestizia	gloom
schiamazzare	noise
badile	shovel
zangola	churn
catenaccio	padlock
fattuchhiero	sorcerer
levriere	grayhound
donnola	weasel
zingaro	gipsy
pellicia	fur coat
bazzicature	trifles
gocciolone	dunce
rampogna	rebuke
tempone	feasting
boccetta	bud
catasta	woodpile
melacatogna	quince
pozzetta	dimple
oltracotanza	forwardness
svogliatezza	disgust

(3) *English vocabulary*

cribriform	sieve-like
ichthyroid	fish-like
lycocop	moss
muniment	charter
stramonium	drug
urticate	sting
coacervation	heap
triturate	pulverize
vapulation	flogging
xoanon	image

zymosis	fermentation
turion	shoot
splanchnic	intestinal
puccoon	dye-plant
pseudechis	snake
glochidiate	barbed
verruca	wart
solferino	purplish
polygonum	plant weed
tintinnabulum	bell

(4) *Arithmetical sums*

For this test the same problems were used that were employed in the first end test. The subjects were instructed in both cases not to waste time in verifying the examples, but to work them as accurately and as rapidly as possible.

(5) '*Opposites*' *test*

A series of twenty-five 'opposites,' similar to those in the first end test. Thus:

west..............	north, east, south, Europe
no................	wrong, right, yes, probably
bottom...........	inside, head, cover, top
after.............	before, later, earlier, when
easy..............	soft, quick, hard, problem
enemy...........	amicable, brother, foreigner, friend
fail..............	win, succeed, try, overcome
	etc., etc.

(6) *Logical memory test*

For this test the story used in the *Otis Group Intelligence Test, Scale A*, was used. The story begins: "Once upon a time there was a king who was very fond of hearing stories . . . ." As in the case of the corresponding story in the first end test, the selection was previously divided into a total of 92 separate ideas, the score of each subject being computed on the basis of the percentage of the entire 92 ideas which she was able to reproduce correctly immediately after auditory presentation of the story.

The results. Following are the results of the experiment.

TABLE XII. SHOWING THE TIME REQUIRED BY EACH SUBJECT IN BOTH END TESTS, AND THE GAIN OR LOSS REPRESENTED IN THE SECOND END TEST OVER THE FIRST. (PRACTICE GROUP.) *

	SUBJECT I			SUBJECT II			SUBJECT III			SUBJECT IV			SUBJECT V			SUBJECT VI		
	M			*D*			*B*			*C*			*F*			*P*		
	1st	2d	Gain or loss	1st	2d	Gain or loss	1st	2d	Gain or loss	1st	2d	Gain or loss	1st	2d	Gain or loss	1st	2d	Gain or loss
French.........	6-45	6-16	+0-29	6-44	7-56	−1-12	12-55	8-59	+3-56	7-51	8-24	−0-33	8-40	8- 9	+0-31	7-23	5-32	+1-51
Italian.....	9- 0	6-50	+2-10	7-50	6-30	+1-20	10-35	6- 4	+4-31	7-25	5-35	+1-50	10-30	5-36	+4-54	8-48	5- 4	+3-44
English	7-10	5-32	+1-38	6-44	5-40	+1- 4	9-47	5-19	+4-28	8- 1	5-18	+2-43	8- 9	5-24	+2-45	..	..	..
Arithmetic.....	8-23	7- 9	+1-14	6- 5	5-20	+0-45	10-24	8-15	+2- 9	10-40	7- 3	+3-37	7-35	5-28	+2- 7	7-15	6-15	+1- 0
Opposites.......	2-21	1-43	+0-38	2-20	1- 1	+1-19	2- 0	1-21	+0-39	1-35	0-53	+0-42	1-15	0-35	+0-40	..	..	..
Logical Memory	70%	74%	+4%	94%	72%	−22%	70%	71%	+1%	66%	76%	+10%	86%	74%	−12%	..	..	..

* The notation in this and the succeeding tables is given in minutes and seconds. Thus, Subject M required 6 minutes and 45 seconds in the first French test and 6 minutes and 16 seconds in the second French test, which represents a gain (+) of 0 minutes and 29 seconds for the latter.

TABLE XIII. SAME DATA FOR THE CONTROL GROUP

	SUBJECT I			SUBJECT II			SUBJECT III			SUBJECT IV			SUBJECT V			SUBJECT VI			SUBJECT VII		
	M			*T*			*S*			*H*			*Th*			*Ma*			*Sb*		
French.....	6– 5	4–42	+1–23	9–35	4–57	+4–38	9–31	3–57	+5–34	4–40	6–35	–1–55	..	..	..	4–20	4–12	+0– 8	3–42	4– 1	–0–19
Italian	4–52	3–30	+1–22	4–55	3– 5	+1–50	4–54	3–30	+1–24	4–44	4– 0	+0–44	4–31	2–16	+2–15	4–22	3–13	+1– 9	2–54	4– 5	–1–11
English	5–40	2–49	+2–57	6–22	2–22	+4– 0	3–45	2–40	+1– 5	4–49	2–16	+2–33	3–28	3–12	+0–16	2–53	2–28	+0–25	2–50	3–12	–0–22
Arithmetic..	7–55	7–28	+0–27	6–24	6–25	–0– 1	5– 5	4–50	+0–15	8–52	8–20	+0–32	8–10	6–22	+1–48	12–9	9–10	+2–59	8–20	6–45	+1–35
Opposites..	1–33	1– 2	+0–31	1–42	0–47	+0–55	1–40	0–55	+0–45	1–40	1– 3	+0–37	2–22	1–28	+0–54	1–42	1–10	+0–32	2– 0	1– 4	+0–56
Logical Memory...	67%	87%	+20%	81%	86%	+5%	75%	87%	+12%	88%	92%	+4%	69%	77%	+8%	66%	80%	+14%	66%	71%	+ 5%

TABLE XIV.

INDICATING AVERAGE GAIN FOR EACH GROUP AND AVERAGE RESIDUAL GAIN IN FAVOR OF PRACTICE GROUP

	AVERAGE GAIN BY PRACTICE GROUP	AVERAGE GAIN BY CONTROL GROUP	RESIDUAL GAIN BY GROUPS	REMARKS
French	1–42	2–56	1–14 (control)	2 subjects in each group showed a loss
Italian	3–5	1–27	1–38 (practice)	1 subject in control group showed a loss
English	2–26	1–52	0–34 (practice)	1 subject in control group showed a loss
Arithmetic	1–49	1–16	0–33 (practice)	1 subject in control group showed a loss
Opposites	0–48	0–44	0–4 (practice)	all subjects in both groups showed a gain
Logical Memory	5 per cent	10 per cent	5 per cent (control)	2 subjects in practice group showed a loss

Conclusions. The following conclusions seem warranted by the evidence produced by the experiment:

(1) Improvement in ability to learn French, Italian, and English vocabularies, to solve simple problems in addition, to think of opposites, and to remember the ideas in a story, takes place in subjects who have had training in learning Spanish vocabularies; it also takes place in subjects who

TABLE XV.

SHOWING NUMBER OF SUBJECTS WHOSE RECORDS ARE INCLUDED IN AVERAGES OF PRECEDING TABLE

	NO. SUBJECTS IN PRACTICE GROUP	NO. SUBJECTS IN CONTROL GROUP	REMARKS
French	4	4	The two subjects who lost in each group cancel each other
Italian	6	6	1 subject in control group who lost not included
English	5	6	1 subject in control group who lost disregarded
Arithmetic	6	6	1 subject in control group who lost disregarded
Opposites	5	7	
Logical Memory	3	7	2 subjects in practice group who lost disregarded.

have had no interim training. The mere circumstance of having performed the first end tests renders a person able to perform final end tests, of identical nature, more quickly and economically. Of the aggregate of twenty-nine final end tests sustained by the practice group, there occurred improvement in all but four; while of the aggregate of thirty-six final end tests sustained by the control group, improvement occurred in all but five.

(2) In four of the six tests the practice group made residual gain; viz: Italian vocabulary, English vocabulary,

arithmetical sums, and 'opposites.' In the two other tests (French and logical memory), the residual gain was on the side of the control group. It would seem, therefore, that those individuals who practiced learning Spanish vocabularies were slightly more efficient in the second end test than were those individuals who lacked such practice. In other words, there appears to have been some slight transfer.

(3) Practice in learning Spanish words appears to have transferred to the learning of Italian and English words, but not (at least not residually) to the learning of French words. There seems to be no satisfactory explanation of this in the nature of the experiment itself. I am inclined to think that either some extraneous factor or factors chanced to effect disastrously the records of the practice group in one or the other of the end tests in French, or else that the time spent by the control group on the first end test in French was sufficient to swing the subjects again into the French-language-consciousness, so that in the final test they were able to perform much more expeditiously. The latter explanation seems the more plausible, particularly since the students in the practice group, none of whom showed a remarkable gain in French, were at the time of the experiment having a course in French, while those in the control group who gained in the neighborhood of one hundred per cent had not studied French for nearly two years. The former had obviously a vivid feeling for the language at the outset, while the latter had rather an indefinite and confused memory of French, which, however, cleared up considerably after a few minutes of practice in studying it.

The residual gain of five per cent in logical memory indicated by the control group is so slight as to be negligible, so far as affecting the question of transfer is concerned. In fact, the results in the 'opposites test' and the logical memory test may be looked upon as cancelling each other.

Transfer through identical elements. The explanation of transference of training most commonly accepted to-day is that proposed by Thorndike and others, known as the theory of identical elements. According to this conception, improvement in any given mental function rarely if ever results in the bolstering up of any other function, however similar, since "the working of every mental function group is conditioned by the nature of the data in every particular case." It is believed that when improvement in learning one datum is shown to occur as a result of practice in another datum, it is because of a similarity which exists between the two. This similarity, or 'identity' as it is more commonly called, may be either a similarity in *substance*, in *procedure*, or in *aim*. In the experiment outlined above, for example, identity of substance occurs in the equivalency of the practice series (Spanish vocabulary) and at least the first three end tests (French, Italian, and English vocabularies). The substance or content is the same: twenty unfamiliar words. Identity of procedure or form occurs in the equivalency of the methods employed in learning a Spanish vocabulary and in learning a French, Italian, or English vocabulary: twenty unfamiliar words to be learned by heart up to the point where, by covering up the unfamiliar word with my hand, I am able to think quickly of its associated meaning. Identity of procedure occurs also in all six of the end tests and the practice tests in waiting for the 'Go' signal, and in concentrating the attention exclusively on the learning. Identity of aim or ideal occurs likewise in all six of the tests and the practice series: to do my very best; to rule out distracting influences; to improve upon my previous records; etc. It is only in the first three end tests that all three identities (substance, procedure, and aim) occur, and it is interesting to note that it is in these that the greatest amount of gain was shown by both groups.

Hewins summarizes[1] the consensus of belief concerning the matter of transfer as it has been built up upon scientific investigation, thus:

---

[1] Hewins, Nellie P. *The Doctrine of Formal Discipline in the Light of Experimental Investigation*, pp. 46–47.

> Ebert and Meumann, Coover and Angell, Judd, Winch, Wallin, Fracker, Urbantschitsch, Münsterberg, Dallenbach, and Spearman may be considered among the more prominent proponents of the doctrine of formal discipline. On the other hand, Thorndike and Woodworth, Stone, Sleight, Burt, Heck, Whipple, Swift, Bolton, DeGarmo, Henderson, Jastrow, Norsworthy, and Squire . . . align themselves in the main with the opposition. Nearly all admit improvability with practice and its transference to material, similar or closely related in content or form. Prominent among the believers in a "spread of training" where "identical elements" exist are Thorndike and Woodworth, Whipple, Starch, and Sleight. . . . All psychologists seem to be in accord that where there is identity of substance, improvement increases according to the general laws of a practice curve until a physiological limit has been reached. Among those who emphasize identity of method or procedure as an explanation of transference, with great stress on the importance of concentration of attention, are Thorndike and Woodworth, Münsterberg, Angell, Coover, Bagley, Ruger, Judd, and Fracker. Ruediger, Ruger, Lewis, and Bagley are impressed with the necessity for an aim or ideal.

General conclusion as to transfer of training. We have seen in the preceding pages, first, that the question of transference of training has a very practical bearing upon the content of the educational program; second, that a large number and a wide range of carefully controlled experiments have been conducted by the educators interested in arriving at a rational solution of the problem; third, that notwithstanding the broad scope and careful direction of these experiments, the results which they have yielded have been differently interpreted by different investigators; and, fourth, that there is considerable agreement among them that improvement is due to identity of substance, procedure, or aim in the several types of data investigated.

In conclusion, it may be said that there is little doubt about the transferability of the effects of practice from one datum to another which is closely related. What the experimentalist is now chiefly interested in doing is discovering the condition under which practice effects are thus transferred, and how varied the data may be in which the phenomenon occurs. As Spearman puts it,[1] the attack of the opponents of general discipline "is not against formalism utterly, but against unqualified formalism." And again, the "two chief opposing schools are at cross-purposes; the one is defending what may be called qualified formalism, while the other is attacking unqualified formalism." Many of the invectives hurled back and forth between the opposing camps miss fire, in other words, because the issue is not always clearly defined; one camp is not infrequently defending one thing, while the other is attacking something else.

In the mean time it is incumbent upon the teacher to keep an open mind in the controversy, remembering that investigation has not yet gone far enough to warrant the establishment of unassailable conclusions. The wisest course for her to pursue is to teach each subject in the curriculum with all the art and skill at her command, serene in the conviction that whatever general transfer value it may have to other subjects will be realized best if the specific learning has been well and effectively accomplished. With such final shaping or re-shaping of the course of study as may be suggested by the experimental evidence supplied by the investigators she is not immediately concerned. At the same time junior and senior high-school teachers in particular would do well to appreciate vividly the fact that they are in an ideal position to carry on simple experimental work in this field, and that an eager educational public awaits any light which they may be able to throw upon this baffling and age-old problem. The example of Miss Hewins, a high-school teacher in New York City, who has written an excellent monograph on the subject, based upon an original experiment of her own in the schoolroom, should be a stimulating and suggestive one to every upper-grade teacher.

---

[1] Spearman, C. "Qualified and Unqualified Formal Training"; in *Journal of Experimental Pedagogy*, March, 1914.

QUESTIONS AND PROBLEMS

1. The bearings of the Herbartian psychology upon the doctrine of formal discipline.
2. Effects of a possible future complete explosion of the doctrine of formal discipline upon: (*a*) elementary education; (*b*) secondary education; and (*c*) higher education.
3. Effects of a possible substantiation of the doctrine upon the three educational levels mentioned in 2.
4. Other experimental investigations of transference than those referred to in Lesson 16.
5. Read and report upon some article in the current educational literature bearing upon the transference of the results of practice. Cf. especially such journals as *School and Society*, *Journal of Educational Psychology*, *Educational Review*, etc., etc.
6. In Lesson 16 we have been concerned with the question of transference of habits. Is there any evidence of *interference* of one set of habits with another set?

SELECTED REFERENCES

1. Colvin, S. S. *The Learning Process*, chapters 14, 15, and 16.
2. Hewins, N. P. *The Doctrine of Formal Discipline in the Light of Experimental Investigation.* (Part I summarizes the literature on the subject; Part II presents an original contribution to it.)
3. *Monroe's Cyclopedia of Education.* Article on "Formal Discipline" (by Henderson).
4. O'Shea, M. V. *Education as Adjustment*, chapters 13 and 14.
5. Pyle, W. H. *The Psychology of Learning*, chapter 11.

[illegible]

LESSON 17

BUILDING A WELL-ADJUSTED PERSONALITY

Personality and the learning process. In the popular mind, at least, to go to school means to memorize certain facts and to learn certain mental and motor controls or skills. The learning process is commonly conceived as consisting of those stages by and through which a child comes into possession of the racial past and, to some extent, of the social present. The material is presumed to exist largely in books and works of reference. The task of the pupil-learner is assumed to be the perennial translation of that material from the printed page into the pervious reception chambers of his own mind. Looked at from this viewpoint, learning becomes little more than a process of absorption of ideas and information which the brain cells store up faithfully, and which they automatically discharge whenever the appropriate situations and contexts of later experience cause them to be released. It considers the learner a passive machine rather than a reacting, impressionable personality that is fashioned and moulded by every influence which plays upon him.

The educationist is not, however, content with this mechanistic view of the learning process. He agrees, of course, that the mastering of certain intellectual and muscular skills is an important phase of it. Possession of the racial past and the social present he recognizes as an extremely necessary item in it. Books and reference works and other common materials of the classroom, he agrees, are invaluable and indispensable sources of knowledge. That their contents are to be translated into the life and the thoughts and the ideals of the pupil, he readily admits. But when all these results of the learning process have been achieved, he insists that the greatest result of all is still largely unprovided for; namely: the building of a harmonious and well-adjusted personality.

Mental hygiene and the learning process. The learning process is not then limited to the mere acquisition of knowledge and skill: these are but the objective, impersonal results, tangible and measurable. The learning process involves also an individual and subjective unfolding of the self which is at once intangible and unmeasurable. The learner is both an absorbing mechanism and a reacting personality. A page of history, a laboratory experiment, a field trip, a piece of literature, a mathematical problem, a beautiful picture — these and all other schoolroom experiences not only afford the material of knowledge and skill, but they also furnish the framework upon which individuality and personality are builded.

One learner responds to an educational situation thoughtfully, eagerly, confidently; another, of perhaps no less ability, responds to the same situation superficially, passively, hesitatingly. In a brief time these two opposite extremes of response tend to become fixed, through the operation of the law of habit, and the resultant distinct personalities are practically thus predetermined. One learner finds it easy and agreeable to adjust himself to this subject and to that, or to this procedure or that; another finds it extremely difficult and often all but impossible to make the common adjustments of method, attitude, viewpoint, etc., required in school work. One type of child mind is 'set' for fanciful revery, another for realistic considerations; one tends to enjoy concentrated thought, another to dislike it; one seeks problems to solve, another avoids them; one is open-minded, another opaque; one exhausts all the available sources of information upon the problem at hand, another is content with a minimum of search and inquiry.

On the feeling and volitional sides of behavior there are equally striking contrasts among pupil-learners. One child is developing a cheerful, sunny disposition in connection with and as a result of his schoolroom experiences, while another is in extreme danger of becoming gloomy and morose. One pupil wills to do his best, another to do as little as possible. One finds encouragement and even inspiration in his daily tasks, another finds discouragement and *ennui*. One grows in self-confidence, another in diffidence. Some children are ready and eager at all times to express themselves; other children are reticent and in danger of becoming morbidly self-conscious and retiring. Some are growing in self-reliance; others in dependence upon the teacher or other learners. For this pupil, every item in the school day becomes a means of stimulating self-activity, thoughtfulness, and original reaction; in that pupil the daily rounds tend to confirm habits of inertia and mental sluggishness. This child is growing in ability to plan out and execute a new line of attack; that child slavishly imitates methods which he learned yesterday, and makes little if any effort to bring his own individuality to bear upon his problems. One is self-controlled, another suggestible and irresponsible; one is serene, another easily irritated; one is bold, another timid; one adjusts readily to other personalities, another poorly; one is buoyant in his work, another is depressed and irritated by it.

Cases of negative adjustment. In a word, there are found to exist in every schoolroom pupils who are adapting themselves to the work of the school in an unfortunately negative manner. This lack of rational adjustment to the school environment expresses itself not only in the neutral, colorless quality of the work done, but — more unfortunately still — in the establishing of those mental, emotional, and volitional habits and attitudes which, given opportunity to develop, become a little later the very earmarks of the unstable and ill-balanced personality.

The following illustration[1] represents the extreme of maladjustment in a child to his general school environment. It is a portion of a letter written by a pupil who had found it impossible to adjust himself to the hard and humbling realities of his school life.

---

[1] Taken from *The New Psychology and the Teacher*, by H. Crichton Miller, p. 50.

> .... I have been expecting for many years to become the most wonderful man upon this earth — in fact, you can hardly say upon this earth, exactly, as I shall be immortal. I shall have magic lifts, which will run between heaven and earth. Heaven will be my native land, and I shall be sort of let into Heaven by the back door, so to speak. That is to say that I expect I shall not be like an ordinary human being, but if God will give me all these things, I will pay him back by doing all the work set forth by my Father to my utmost capability. . . . I shall have an absolutely new and perfect immortal body, which can be suited to either climates. It will also be controlled by electricity throughout, controlled by switches fastened in my body, enabling me to have: (1) strength to give the most collosal kick known; (2) to make myself invisible; (3) to fly through the air. I shall know all that is known or can ever be known, including all the languages of the world. . . . I shall have as much money as I want, my allowance being £1 per day, or £6 10s per week. . . . The fare, which goes to the Heaven Lift Company (the power station of which will be in the Upper World) will be 3d. . . . I presume that I shall wake up in Heaven some morning in a sort of motor-car bed, in the sunshine of this new world, and can imagine running about the town in this car.

The teacher a practical mental hygienist. Most children, it must be admitted, do not seek release from the routine of their school environment in compensating phantasies so extreme as this. It is a matter of common observation, however, that those pupil-learners who are unable or unwilling to adjust themselves completely and unreservedly to the exigencies of their daily tasks are taking the first fatal steps toward a withdrawal from reality, with all the possibilities of future neurosis and psychosis which are the logical culmination of such faulty adaptation to the work of the present moment. At their worst, maladjustments of this sort lead to instability and unbalance; at their best, they lead to unsympathetic, ambitionless, irresponsible personalities that can play no constructive or positive rôles in the great, practical, energetic world of men.

It is of supreme importance, therefore, in order to prevent and forestall these faulty adjustments to the general educative process, that teachers be practical mental hygienists of the first order. It is essential that they comprehend the importance of whole-hearted activity, hard work, and a normal affective and volitional discharge in order that they may influence favorably the building of balanced personalities and strong individualities in their pupils. They need to feel keenly the fact that personality evolves largely as a concomitant by-product of the educative process, and that the child who is confronted with this classroom exercise or with that, is confronted also with a situation out of which inevitably he is to hew a fundamental individuality, a characteristic *self*. They must understand that every educative situation is fraught with possibilities both positive and negative in this respect, and that each child presents an individual potentiality which may urge him in one direction or the other.

They must recognize, of course, the undesirability of striving to make all their pupils alike, to stamp them in the same mould, for this would mean the annihilation of personality; yet at the same time, while providing for the fullest development of individuality, they must see to it that the learning process affords the pupils no opportunity and no inclination to react abnormally, or out of reasonable adjustment with the situation at hand. Inattentiveness, obstinacy, arrogance, sulkiness, moroseness, indecision, reticence, horse play, and other non-conforming habits and attitudes become easily fixed in many children. The cause may be either inefficient and unmotivated teaching, or it may lie within the nature of the individual child. Whatever their cause, such tendencies must be discouraged in the interests of a well-balanced and integrated personality. Positivism rather than negativism is the foundation of mental health, and the first stones are laid in the classroom.

The intellect and personality. The human mind is commonly thought of as a tri-partite unit made up of knowledge, feeling, and volition. In the following paragraphs we shall endeavor to indicate the importance of all three of these aspects of mind as attributes of the personality or self, especially as they take their rise in the learning situation.

Clarence and Earl are two eighth-grade boys in a class of thirty-five. Both are of similar native intelligence, as indicated by their standing in the *National Intelligence Tests,* the former's score being 138 and the latter's 140. The class median was 138, so that not only are these two pupils similar to one another intellectually, but they are also representative children of their group. Notwithstanding their apparent intellectual equivalency, as indicated by the test scores, these two boys are quite the reverse of each other in certain fundamental intellectual traits and attitudes — so much so indeed that their personalities bear only the slightest resemblance to one another. Clarence likes nothing better than to meet an interesting or challenging problem in connection with his lessons. I have seen him furrow his brows in deep concentration over some statement which he either failed to comprehend or was inclined to question. I have known him to discover and exhaust sources of information that other pupils were entirely unaware of. One of the most delightful experiences is to watch his expression of countenance at the moment when new meanings and new relationships dawn upon his mind as a result of such investigation and thought. Earl, on the other hand, finds thinking rather distasteful. He prefers to rely upon momentary flashes of insight rather than to go to the trouble of thinking out a situation systematically. While Clarence's mind is unfolding so definitely that one can almost see the process, Earl's thoughts are likely to be wool-gathering. He is bored rather than challenged by a new or baffling problem. Rarely if ever does he set out with determination to seek and to find. He listens respect-fully while others are speaking and planning and explaining, although his teacher would be often unable to say where his thoughts are. His mind is of the 'scatter' type, jumping hither and thither without let or hindrance.

Clarence maintains an interestingly critical attitude toward his work and the subject-matter of his lessons, though he is never offensive or impolite. If his experience has been otherwise than that of some one else — author, teacher, or fellow pupil — he is not backward about making known the fact. Earl, on the other hand, is passive, indifferent, colorless. I am not sure but that, if some one were to tell him he was a South Sea Islander, he would acquiesce without much demurring; certainly he would find pleasure in entertaining the idea. Clarence is a realist, a practical workman; Earl is a day-dreamer, a visionary, given to fancy and passive play of the imagination. The one enjoys focussing all his energies upon the immediate and the imminent; the other finds it distasteful to clip the wings of his own soaring phantasy and compel himself to master the present problem. Called back to the realities in a lesson in arithmetic, or history, or grammar, Earl descends to earth with almost a mental thud, where for a few moments his spirit remains, sluggish and indifferent, among the lowly hewers of wood and drawers of water.

Diagnosis and reëducation. Earl's case is by no means a hopeless one, but it is one that demands skillful handling. The eventual slant of his personality will be dependent pretty largely on the methods which his teachers employ in helping him to build up systematic powers of attentive control and mastery of an errant imagination. By a gradual but insistent process of reëducation, Earl may yet be saved to the world of achievement. He is bright, has good health, mixes well with other children, and has other excellent qualities, not excepting even his imagination. If his teachers, by sympathetic study of his peculiarities, can only really *discover* that interesting mind of his they will find some secure basis somewhere for the erection of a superstructure of personality and individuality that will endure as long as the best.

But the process of diagnosis and reëducation cannot begin too soon. Habits of inattention, wool-gathering, fanciful rumination, become fixed as firmly as any other habits in the course of a few years. If Earl is to grow up a worth-while, responsible member of society, he must be led speedily to gain control over his concentrative powers, to feel a normal, even eager interest in his school work, to find pleasure in mental application, to be active, alert, and positive in all the situations of the educative process. Mental health means reasonable adjustment to the realities and actualities of daily life; mental illness means maladjustment to them. These maladjustments are formed just as readily in connection with the learning process as with any other.

Miller is insisting on these matters when he says:[1]

> The clinical psychologist has special opportunities of realizing the importance of attention in the individual's equipment for life. Failure to develop adequate power of attentive control often manifests itself in later life in ill-health of body and mind, and it falls to the physician to correct it as best he may by a process of re-education. The neurotic patient is often the victim of indecision: he cannot make up his mind on any subject; he has lost all will-power. The tendency in modern psychology is to make will and attention synonymous; and it is a tendency that is supported by the experience of psychotherapists. The temperament that is sometimes contemptuously dismissed as 'neurotic' is often endowed with great gifts and capabilities, which have been allowed to run to waste for lack of the necessary training. Much can be done in later life by a careful technique of re-education; but the original failure in the early training of the faculties of attentive control has been responsible for much irretrievable loss both in individual happiness and social usefulness.

The feelings and personality. The individual who is well adjusted to his environment is necessarily confident and optimistic. His dynamic affective tone is one of satisfaction and content. If he dreams dreams and sees visions of a broader horizon and greater achievements for himself, that does not make any less real the pleasurableness accompanying present accomplishment. Such a personality adjusts without friction to the new, and is at the same time inspired and drawn on toward the to-morrow. The ill-adapted individual, however, is not so. His emotions are inimical to his own best development. He lacks confidence in the present and the future; he is moody, suspicious, ill-humored, unhappy, pessimistic. His dominant affective tone is one of unpleasurableness. There is more or less perpetual friction between his emotional self and the realities and the actualities of his environment and work in life.

---

[1] Miller, H. Crichton. *The New Psychology and the Teacher*, p. 28.

Recent laboratory experiments have demonstrated,[1] with almost startling vividness, the interaction of the bodily functions and the major emotional states. LeConte, a French investigator, experimenting upon dogs, found that when they were brought into strange surroundings (fear) the secretion of gastric juice was often completely stopped. Oechsler, a German investigator, has gone a step further than LeConte, and found that emotional maladjustments will not only modify the gastric secretions but may even stop completely the secretion of pancreatic juice and definitely diminish the flow of bile. Dr. Cannon reports observing the movements of cats' stomachs by means of the Roentgen rays. The animals were fastened in a holder which, though perfectly comfortable, aroused fear in them to the extent that the peristaltic waves ceased wholly. Other stimuli which aroused either fear or rage resulted in the same cessation of digestive movements in the stomach and also in the small and large intestines. In other investigations it has been shown that the activity of the glands of internal secretion, notably the adrenal, is profoundly modified by emotional states of the negative and depressing sort.

---

[1] See especially *Bodily Changes in Pain, Anger, Fear, and Rage*, by Professor W. B. Cannon, for a detailed account of the intimate relationship between the emotions and the bodily functions.

The evidence is indisputable that unpleasant, annoying affective experiences are reflected directly in the modification of certain organic processes vital to the health and buoyancy of the organism. Wise and proper emotional adaptation to the environment is therefore doubly important: physical hygiene and mental hygiene are both dependent upon it. The teacher of the future will understand that the men and women of the rising generation are already as school children, confronted with this educative situation and with that, forming fixed and unchangeable emotional habits, and will so analyze and evaluate her own technique and methodology that the feeling states of her pupils shall be hygienic and positive. She will understand that a school system and a schoolroom and a school teacher are far more than the mechanical and formal provisions of society for introducing the child to his racial past and social present: she will be impressed with the supplementary and often intangible and incidental aspect of the whole process — the building of self, of positive, exuberant personality. Only when teachers appreciate that the affective totality of an individual life is constructed thus inevitably day by day, from the satisfyingness or annoyance attendant upon the routine tasks of the learning process, shall we be justified in expecting to see the mature fruits of early wise adjustment to the exigencies and circumstances of the environment.

The program for the school. Dr. Burnham has shown [1] how large a factor is success in the work of the school in helping the child to adjust himself positively to its performance, and points out the importance of so bringing it about that in some connection or other every learner shall feel often the thrill and enthusiasm of *success*. There is no greater emotional tonic of the constructive sort than this, and lack of it undoubtedly tends to foster in the pupil the genesis and growth of the destructive and negative type; that is, of faulty adjustment to the environment attendant upon the learning process.

---

[1] Burnham, Wm. H. "Success and Failure as Conditions of Mental Health"; in *Mental Hygiene*, vol. III. 1919.

La Rue, in the final chapter of his book, enumerates[1] thus other indications of maladjustment:

> What signs shall we look for so as to recognize poor self-management or bad adaptation? Some of the symptoms, especially those which may indicate future evil, are seclusiveness, over-secretiveness, lack of frankness, moodiness, inability to get along with others and make friends; excessive day-dreaming, brooding, foolish fancies, and impossible plans; sensitiveness, touchiness, over-quickness at scenting insult or injury, harboring of resentment or unfounded suspicions; self-pity, great depression, self-depreciation; tendency to remain crushed if defeated, excessive indecision, great anxiety, timidity, fear, or worry; sexual vagaries, and peculiar behavior of all sorts.

These symptoms, indicating as they do faulty adjustment, may be taken as among the most common earmarks of evolving neurosis, and it should be a very significant part of the work of the teacher to detect them in their incipiency and strive, with all possible refinement of motivation, method, and art to aid the victims to overcome obvious tendencies which they may have in any of these directions. In general, a program of interesting but not too easy work that has a tangible goal in view; participated actively and socially in by every learner; requiring planning and searching and executing; and crowned at suitable periods with the thrill of successful achievement, will accomplish the generation, or haply the regeneration, of right emotional attitudes in every pupil.

Volition and personality. The well-adjusted personality seeks outlet and expression of the self in action that is beneficial and developmental. The growing individual normally strains after tangible, objective self-realization. So long as he thinks and feels merely, there is likelihood of his feet not resting firmly on the ground. The noblest attribute of man is his capacity for volitional, or willed, activity. Through thinking and feeling the road to self-expression leads inevitably to action. Only the ill-adapted individual falls short of the crowning realization of the self in action. The healthy mind not only passively seeks but actively pursues; the unhealthy one may never experience the joy and invigoration which are born of execution.

---

[1] La Rue, Daniel W. *Psychology for Teachers*, pp. 299–300.

In the learning process, therefore, ample provision needs to be made for planning lines of investigation, strategic points of attack, definite conquest of sensed goals. There must be vitally interesting problems, arising spontaneously and naturally wherever possible, in the solution of which every learner shall have a clear and responsible part. History, geography, general science, civics, arithmetic, hygiene, are reeking with such human problems: for shame that these subjects are often taught as so many pages of a dry textbook or reference manual! What wonder that the unstable child, or the meagerly endowed child, or even the perfectly normal child, often falls short of the high goal of the whole educational process: mastery of his own will! Volitional control is achieved largely through active planning and plan-executing, and it can never arise from the phantasy into which the dullness of the learning process frequently drives the learner as a release from the unattractive realities of the present.

It is not our purpose here to contend that the teacher should be charged with responsibility for redeeming from himself every child who is possessed of a neurotic constitution, or who may be laboring under the malign influence of some distinct nervous diathesis. Children of this sort are likely to be cases for the psychiatrist, and teachers are not directly responsible. The fact remains, however, that many a stable child, and many nervous children tottering on the brink of instability, can be happily drawn away from the precipice by being made keenly interested in their school work and given an opportunity to throw the whole weight of their mental and volitional powers into it, or into some phase of it. Little by little they may be led up to the plane where they have learned never to shun problems, whether they be easy or hard, but always to meet and grapple with them. In so far as it is within the bounds of her skill and art thus to aid the child to grow in volitional control and self-mastery, every teacher is and should be charged with deep responsibility.

Suggestion and the teacher. Within recent years the Freudian and other schools of psycho-analysts have been making some very significant discoveries in the realm of the unconscious mind. Some of the adherents of these schools undoubtedly permit their enthusiasms to becloud their more sober judgments; all of them are justified, however, in the emphasis which they place upon the unconscious, or the subconscious, as a determining factor in much of our behavior. The seat of control over fundamental organic processes, and the storehouse of the racial and the individual past, it could not be otherwise than that the influence of the lower stratum of the mind over our conscious activities should be both extensive and profound. Over the aspect of personality projected by the unconscious as a result of racial experience and racial memories we have, of course, no native control. Over those aspects of personality which are projected by it as a direct result of our own individual past experiences, however, we are in a position to exercise control in that we are able to choose within limits what our experiences shall be, and so guard ourselves from future disagreeable and dangerous outcroppings.

Every individual is the sum total of his past reactions, each one of which is stored up in his unconscious mind. I may take a strong initial dislike for *X*, for no other reason than that *X* reminds me unconsciously of *Y*, whom I have not seen or thought of for years, but whom I had good cause to dislike when I knew him. The feeling has been faithfully preserved in the lower levels, and has now attached itself, for no manifest reason, to *X*. Or again, I may cower in fear at a thunderstorm, because a parent or nurse exhibited terror in such a storm when I was but an infant. The association has been accurately preserved in the records of the unconscious mind, though obliterated long since from the conscious. Such being the case, the principle operating in much of modern psychotherapy that extreme care is to be exercised over what is allowed to be given into the keeping of the nervous system in childhood is readily comprehensible. In the words of La Rue:[1]

> As current events are the most important for us, but are still only a very small fraction of history, so our present consciousness is most important for us, but is only a very small fraction of our total life. And as the course of present events is fixed by past events, so our conscious lives are like streams flowing over the bed, smooth or rocky, of our subconsciousness.

The teacher's personality is an important element in the building up of the unconscious minds of the pupils through the power of suggestion. From the very intimate relationships of the schoolroom it is inescapable that the fundamental qualities and characteristics of the teacher shall be reflected with much faithfulness in the characters of the children. It is a matter of common experience, for example, that the teacher who moves about quietly and speaks in subdued tones has ordinarily a quiet school. Modesty, simplicity, and tastefulness in the teacher's dress have likewise their silent influence upon the tastes and ideals of the pupils. But of far greater significance than these objective suggestions are those more strictly subjective. Witness, for example, the effect upon the dispositions of the children of a teacher whose temperament is choleric, or whose dominant moods are irritable, testy, or 'cranky.' Witness, on the other hand, the influence of a happy, sanguine, friendly attitude on the part of a teacher toward her pupils. Note the different effects produced on the learners by a sympathetic and an unsympathetic teacher; a warm, radiating personality, and a distant, cold, reserved one. So with poise and control: the teacher who is master of herself in all situations is a continual object lesson to her pupils, and the importance to them of the quiet suggestion arising from such a personality cannot be overestimated.

---

[1] La Rue, Daniel W. *Psychology for Teachers*, p. 280.

Not all the lessons, in fine, which children learn are contained in books or in reference manuals or other commonly used schoolroom sources; many of the most enduring lessons are neither consciously taught nor consciously studied, but are absorbed all unwittingly from the conduct and attitude of the teacher. In the interests of sound mental hygiene, therefore, it is important that her habits, interests, attitudes, and character shall be worthy of that unconscious absorption which is an inevitable accompaniment of the learning process.

QUESTIONS AND PROBLEMS

1. Types of instability in children.
2. The work of the Society for Mental Hygiene in your State.
3. The meaning and scope of psycho-analysis.
4. Changes in our educational aims, content, and methodology which might aid in the foundation of better adjusted personalities.
5. Successful achievement in the schoolroom as a stimulus of genuine effort.

SELECTED REFERENCES

1. La Rue, Daniel W. *Psychology for Teachers*, chapter 16.
2. McMurry, F. M. *How to Study*, chapter 10.
3. Miller, H. C. *The New Psychology and the Teacher*, chapters 3, 10.
4. Terman, L. M. *The Hygiene of the School Child*, chapters 16, 17, 18.
5. White, W. A. *The Principles of Mental Health*. (General reference.)

APPENDIX

MEASUREMENT AND TABULATION OF THE RESULTS OF LEARNING

Experiments:

33. A class of normal-school students received the following scores in the *Otis Group Intelligence Test, Scale A.* Rearrange the scores; find the median, average, and mode; plot a frequency curve to indicate the distribution; compute the Average Deviation, Standard Deviation, and Probable Error.

Student	*Score*	*Student*	*Score*
1	170	16	202
2	190	17	173
3	184	18	176
4	162	19	184
5	206	20	196
6	168	21	162
7	186	22	189
8	197	23	184
9	167	24	170
10	179	25	166
11	177	26	163
12	164	27	171
13	185	28	179
14	163	29	192
15	176		

34. The same class received the following scores in the *Thurstone Test for College Freshmen and High-School Seniors.* Work out by the Pearson formula the coefficient of correlation between the two sets of scores.

Student	*Score*	*Student*	*Score*	*Student*	*Score*
1	77	11	62	21	92
2	163	12	97	22	104
3	99	13	121	23	83
4	72	14	68	24	80
5	147	15	75	25	63
6	76	16	92	26	90
7	90	17	110	27	85
8	108	18	83	28	84
9	67	19	101	29	111
10	75	20	102		

35. After consultation with your instructor, make a detailed study of one standardized achievement test, if possible giving it to a class of children in the practice school and scoring the results.

36. Work out, according to the Pearson Formula, the intercorrelations between the average grades in language, arithmetic, history, and geography obtained in Experiment 23, p. 257.

A. Educational measurement

The philosophy of educational measurement. In recent years there has grown up considerable interest in the matter of exact measurement of the products of the learning process. Why, it is argued, since we have a unit for measuring practically every process and product encountered by man, from a cubic centimeter of liquid and a calorie of food to a pound of steam and a volt of electricity, should it not be possible and desirable to establish some standard method of measuring the very important product resulting from the learning process? True, the end results of learning are often immaterial and elusive, but that difficulty should not be adjudged insuperable.

There is no doubt but that, in addition to the fact that the present is undeniably an age of standardization, the well-known and universally deplored inaccuracy of school marks as they are ordinarily given has been a prominent factor in the genesis and the evolution of educational measurement. One teacher will have one standard of marking; another will have another. What one teacher adjudges to be worth eighty-five per cent, another will value at seventy-five per cent, and still another at ninety-five per cent. Save in a subject as exact as arithmetic, there is certain to be a wide range of difference between the standards of any two or more persons who are grading papers or calculating the quality of classwork. A pupil who has three teachers is likely to receive three different marks for work of identical quality. Pupils in one school may receive glaringly different grades in a given subject from those received by pupils of similar ability in the same subject in a different school. Thus widely will teachers vary in their estimate of the work of a pupil when the measuring-stick used is their own empirical judgment. The work that would 'pass' a child in School A necessitates 'repeating' in School B.

Studies of teachers' marks. Several interesting investigations of the variance existing between teachers' marks have been made. That by Carter is typical.[1] He tabulated the final marks given pupils graduating from three Milwaukee schools, and compared them with their subsequent standing a few months later, when they were in attendance at the same high school. Table XVI shows the standing of the three groups in the subject of arithmetic at the time of their graduation from the eighth grade.

---

[1] Carter, R. E. "Correlation of Elementary Schools and High Schools"; in *Elementary School Teacher*, vol. XII, pp. 109–18.

TABLE XVI. SHOWING THE STANDING IN ARITHMETIC OF PUPILS IN THREE MILWAUKEE ELEMENTARY SCHOOLS (1911)

	MARKS BELOW 78 PER CENT	BELOW 79 PER CENT	BELOW 82 PER CENT	ABOVE 84 PER CENT	ABOVE 88 PER CENT
School A		1/3		1/3	
School B	2/3				
School C			1/3		1/3

The marks received should warrant the expectation that in high school, under the same teacher, the pupils from School C would stand higher than those from either of the other two, and that those from School B would stand much lower than those from Schools A or C. Carter discovered, however, that "when the rank of the pupils in arithmetic was compared with their rank in algebra, it was found that a greater percentage of School B (the school which gave the lowest marks) excelled in maintaining their original rank or increasing it. In fact, there was a complete reversal of things from what the absolute marks might indicate." Apparently the grading of each of the three elementary teachers was done on a quite different basis from that employed by the high-school teacher.

Particularly interesting in this connection is a study made by Starch and Elliott, who sent[1] a facsimile of an actual examination paper in plane geometry to the mathematics instructors in 116 North Central high schools, with a request that each grade the test on the scale of 100. Notwithstanding the definiteness of the subject-matter of geometry, the investigators found upon tabulating the replies an extremely wide range of opinion as to the worth of the paper. Two instructors ranked it better than ninety per cent; one ranked it below thirty per cent! Twenty considered it eighty per cent, or better; twenty others considered it worth less than sixty per cent. Forty-seven would give it a passing mark, or better (seventy-five per cent); sixty-nine would not pass it.

---

[1] Starch, D., and Elliott, E. C. "Reliability of Grading Work in Mathematics"; in *School Review*, vol. XXI, pp. 254–59.

Not only do different teachers vary in their estimate of a piece of work done in the schoolroom; the same teacher, it has been shown over and over again, is grossly inconsistent in her marking. Thus Starch found,[1] by having each of seven instructors regrade a set of his own papers, some time after the original grading, that in several instances the two marks assigned a given paper differed by as much as ten or fifteen points. It developed also from the same experiment that the mathematics instructors did not agree any more closely with their previous marks than did the language or science teachers.

Still another line on the inaccuracy of teachers' marking is indicated by the various estimates which they make of the relative values of the questions asked in an examination. In a very significant study of this aspect of the reliability and consistency of marks, Inglis has shown[2] that teachers differ widely in their judgments. He received replies from 122 high-school teachers of mathematics in New England and the Middle States, whom he had asked to assign the relative number of points, on the scale of 100, which each of ten questions in plane geometry was worth. Only twenty of the one hundred and twenty-two teachers replying thought a weight of ten should be given to each question. Table XVII shows the data supplied by the one hundred and two instructors who would assign varying weights to the several questions.

Another outcome of the learning process which the conventional examination fails to take into account is the rate at which the pupil answers the questions. The speed at which one works is certainly as good and accurate an index of his ability as is the excellence of the product which he turns out. Pupil A, in the conventional examination, who uses the entire period and barely finishes his paper, is given the same grade as Pupil B, who completes his paper in the first third of the period, assuming of course that his answers are equivalent.

---

[1] Starch, D. *Educational Measurements*, pp. 9 ff.

[2] Inglis, Alexander. "Variability of Judgments in Equalizing Values in Grading"; in *Educational Administration and Supervision*, vol. II, pp. 25–30.

TABLE XVII. ESTIMATES OF 102 TEACHERS OF MATHEMATICS OF THE RELATIVE VALUE OF TEN EXAMINATION QUESTIONS IN PLANE GEOMETRY

(After Inglis)

Number of Judges Assigning Value to each Question

VALUE ASSIGNED (per cent)	1	2	3	4	5	6	7	8	9	10	TOTAL	PER CENT
0						1					1	0.1
1					1						1	0.1
2		1						1	1	1	4	0.4
3	1		1								2	0.2
4		3						1		1	5	0.5
5	14	15	7	1	16	2	8	6	8	19	96	8.8
6	4	7	1	1	6		2	1		13	35	3.4
7	6	3	1	3	6	4	6	2	4	8	43	4.2
8	23	26	15	14	29	6	14	8	7	18	160	15.7
8.5		1					1	1	1		4	0.4
9	3	5	5	4	4		3	3	2	2	31	3.0
10	34	30	44	24	27	34	31	24	16	18	282	27.6
11	2	3	4	6	1	3	2	2	4	1	28	2.8
11.5						1	1	1	1		4	0.4
12	8	6	16	23	6	21	16	24	21	10	151	14.8
12.5		1				1	2	2	2		8	0.8
13	3		2	2	2	3	5	2	2	1	22	2.2
14	1			1		3	1	1	1		8	0.8
15	3	1	5	16	4	18	9	21	26	7	110	10.9
16				2		2		1	3	1	9	0.9
17						1					1	0.1
18			1	1			1	1	2	1	7	0.7
19												0.0
20				3		2			1	1	7	0.7
25				1							1	0.1
Range	12	13	15	20	14	20	13	16	18	18	25	
Average	8.9	8.3	10.0	11.1	8.5	11.5	10.1	11.1	11.6	8.6	10.0	
A.D. (Av.)	2.0	1.9	1.6	2.5	2.0	2.0	2.3	2.5	2.8	2.8	2.4	
Median	9.0	7.5	9.5	10.7	7.8	11.5	9.6	11.1	11.3	7.6		
Med. Dev.	.8	1.8	.6	1.2	1.3	1.2	1.6	1.1	2.8	2.0		
(m)												

Commenting upon this point, Monroe, DeVoss, and Kelly say:[1]

> . . . This practice of ignoring the rate of working probably tends to cause desultory and careless class work (on the part of the rapid workers). Investigation has shown that rapid work and a high degree of quality or accuracy are not incompatible in arithmetic. The same statement could probably be made with reference to reading. Investigation has indicated that a considerable per cent of pupils can be made more accurate in arithmetic by forcing them to work more rapidly. It has also been shown that about three pupils out of four make progress in speed and accuracy at the same time. In view of these facts, it appears that good instruction requires that the teacher give attention to the rate of doing work as well as to the quality of the work done. . . .

It is, of course, a simple matter to secure an index of the rate at which a given pupil works in an examination. All that is necessary is to make it so long that no pupil can complete it; and then by dividing the number of minutes in the period by the number of units done, the teacher easily finds the rate of working maintained by any given pupil.

The standardized achievement test. It is the aim of the standardized educational test to provide a means of examination that shall preserve all the merits of the conventional examination, and at the same time do away with its defects and shortcomings. By reason of scientific construction; uniform methods of giving, scoring, and interpreting; and standardization of norms, the achievement test tends to rule out the personal equation of the individual teacher, the discrepancies in judgment which are found to exist among several teachers, and reduce the entire process of examination to as nearly a mechanical and automatic basis as it is possible to establish. Because it *is* standardized — i.e., has been built up carefully and been given to thousands of pupils in order to establish tentative norms before being submitted to the educational public — the achievement test is withal a reasonably trustworthy and universally applicable instrument of precision. At least it aims and tends so to be.

A given test will yield the same returns in a Seattle schoolroom as in a Chicago or Boston one, so far as the teacher and the tabulator are concerned. Scored by a Philadelphia or a Louisville or an Austin teacher, a given test will yield in most cases identical results, and in practically all cases approximately equivalent results. Scored again and again by the same individual, a given test will vary only an infinitesimal amount, if any at all. Speed and accuracy are tested simultaneously, so that those pupils who are the most rapid workers may be singled out from the rest, as may also those who are slowest. In these and other ways the achievement test is a reasonably dependable measuring-stick both of educational *status quo* and of rate of progress.

---

[1] Monroe, W. S., DeVoss, J. C., and Kelly, F. J. *Educational Tests and Measurements*, p. 12.

The standardized test is of value to the teacher, because it provides her with such a ready and universally accepted measuring-stick; through its application she can determine the relative achievement of every pupil in every subject, can feel out the weak places of individuals in this subject and in that, and can measure the progress which they are making. It is of value to the superintendent, because it places in his hands an effective method of determining the relative teaching efficiency of, say, his seventh-grade teachers, as evidenced by the classroom product. It is of value to the educational research worker and surveyor, because it enables him to judge the efficiency of a given school system, *X*, so far as the quality of its teaching service is concerned, as compared with that of other systems, *Y* and *Z*, in other parts of the state or country. Finally, the achievement test is of value to the pupil himself, because it gives him an opportunity to see how he measures up to the accepted standard for his age or grade in the several curricular subjects. Knowing his shortcomings in handwriting, or arithmetical fundamentals, or spelling, etc., he is given an added motive to do his best in order that he may approximate the approved standard. The oftimes elusive and hazy goal of education is perceptibly focussed and steadied.

Present limitations. It must not be concluded, however, that educational tests leave nothing to be desired in the way of scientific measurement. The whole matter is only yet in its infancy, and the infant is still in its swaddling clothes. Many educators of repute have little confidence in the measurement idea as applied to so intangible and individual a process as education. Considerable knowledge of statistical methods is needed by one who is to make any extensive use of the scales. The same set of scores will often suggest a conclusion to one investigator which another investigator will discount heavily. Test blanks are an item of considerable expense, which many superintendents and school boards do not as yet feel justified in recommending that taxpayers assume. The number of available tests in all subjects is being multiplied daily, and consequently extensive application and study of the few more promising ones are hampered. A large number of teachers look askance upon any considerable employment of tests because they do not relish the scoring, and may tremble at the possible weaknesses and deficiencies in their teaching methods which they may reveal. The fact that many tests require merely the underscoring of certain words antagonizes those practical teachers who feel that the training the pupil gets in putting his thoughts into sentences and paragraphs is one of the most valuable features of an examination.

These and other criticisms have been made of achievement tests in general.[1] The fact remains, however, that for occasional definite diagnostic purposes the educational test represents the most hopeful instrument thus far conceived. Many of the objections offered to standardized measurement of achievement in school subjects are superficial; some of them are provincial; none should prove ultimately insuperable. The wise teacher and the wise educationist generally will give the tests a fair, unbiased trial, and will attempt to derive whatever advantages are obtainable from their use; in the mean time recognizing the fact that they present a new departure in the educational world, and awaiting with interest their improvement and refinement.

Two examples of standardized tests. From all the scores of available tests we select two, as illustrative of standardized achievement examinations in general:[2] the first, an arithmetic test; and the second, a silent reading test.

1. *Monroe's Standardized General Survey Arithmetic Scale.* (Scale II, for Grades 6, 7, and 8. Form I.) This scale is in the nature of a four-page folder, containing seven different types of problems. After the folders have been passed out, the following general instructions are given: "Do as many of the examples as you can in the time allowed. Do not check your work, but try to have each example right the first time you do it. Try each example once, and then pass to the next. The first test is addition. You are to write down the sums of the examples. Do not begin

---

[1] Few indeed if any would argue that the old conventional examination ought to be wholly superseded by the new diagnostic tests. Rather, the best opinion would retain the former on occasion and substitute for it the latter on occasion. For an excellent discussion of this point the student is referred to an article in the *Yale Review*, for January, 1923.

[2] Reproduced here, in part, by permission of Public School Publishing Company, Bloomington, Ill., from whom these and other tests may be secured in any quantity.

work until I give the signal. Attention! Pencils up! Ready, Go!" After exactly four minutes: "Stop! Attention! Do not do any more of the examples. Do not begin work on the next test." The same procedure is followed out for each of the other six series of examples. For each of the first three sets, four minutes are allowed; for the fourth and seventh one minute each; for the fifth, two minutes; and for the sixth one and a half minutes. At the top of the first page are blank spaces for the pupil's name, sex, age, birthday, grade, school, date of the examination, etc., each one of which is to be correctly filled in before the test is started.

Following are some of the examples:

Test No. 1 — Addition

$$\begin{array}{r}7862\\5013\\1761\\5872\\\underline{3739}\end{array}\qquad\qquad\begin{array}{r}6772\\6028\\6535\\2340\\\underline{2319}\end{array}\qquad\qquad\begin{array}{r}7917\\4304\\9027\\9975\\\underline{1247}\end{array}$$

(14 examples in the scale)

Test No. 2 — Multiplication

$$\begin{array}{r}4857\\\underline{36}\end{array}\qquad\qquad\begin{array}{r}3786\\\underline{49}\end{array}\qquad\qquad\begin{array}{r}5739\\\underline{85}\end{array}$$

(16 examples in the scale)

Test No. 3 — Division

$$41\overline{)574}\qquad\qquad 84\overline{)1932}\qquad\qquad 67\overline{)39932}$$

(20 examples in the scale)

Test No. 4 — Subtraction

$$\begin{array}{r}739\\\underline{367}\end{array}\qquad\qquad\begin{array}{r}877\\\underline{618}\end{array}\qquad\qquad\begin{array}{r}1316\\\underline{827}\end{array}$$

(24 examples in the scale)

Test No. 5 — Addition and Subtraction of Fractions

$$\frac{1}{6}+\frac{1}{3}=\qquad\qquad\frac{3}{4}-\frac{1}{3}=\qquad\qquad\frac{4}{7}+\frac{3}{5}=$$

(15 examples in the scale)

Test No. 6 — Multiplication and Division of Fractions

$$2/5 \times 3/4 = \qquad\qquad 7/12 \div 4/9 = \qquad\qquad 1/6 \times 3/10 =$$

(15 examples in the scale)

Test No. 7 — Decimal Fractions

$.03\underline{)16.2}$ Ans.: 54 $.07\underline{)8.61}$ Ans.: 123 $.08\underline{)44.8}$ **Ans.: 56**

(Decimal point and ciphers, if needed, to be placed. 24 examples in the scale.)

The pupil's score for each test is placed in a space provided for it in the upper right-hand corner of the test. The total score for the pupil is the number of examples he has done correctly. For tests 5, 6, and 7 it is necessary to multiply the individual score by 2, in order to give it the proper weight in the total score.

2. Thorndike-McCall Reading Scale. (Form 1, for all grades.) As its sub-title suggests, this is a test for the understanding of sentences.[1] It is in the nature of an eight-page booklet, comprising several paragraphs upon which certain questions are based. These questions may be answered in most cases by a single word, and blank spaces are provided for the answers after each question. After the booklets have been distributed, and the identification spaces filled in on the first page, the teacher reads the first (sample) paragraph aloud while the pupils read silently. She then reads the first question aloud, and it is answered orally by the pupils. The three additional (sample) questions are then asked and answered in the same way, after which the page is turned over and the signal to begin is given. Exactly thirty minutes are allowed for the test.

One of the eleven paragraphs, and the questions based upon it, follows:

In the spring men begin to work the soil. Those who have small gardens break up the ground with such tools as spades and forks. Those who live on farms turn the soil over with ploughs drawn by horses. In these ways the soil is loosened. After the planting is done, the weeds must be killed and the soil must be loosened. In places where little rain falls, other ways of watering the plants must be found.

11. In what season of the year is ploughing done?..................
12. Write the names of two tools which are used to loosen the soil in a garden..
13. What is the first thing the farmer does to the soil to make it fit to grow plants?......................................

The score of a pupil is computed by first totaling the number of questions correctly answered, and referring this total to a table

---

[1] Reproduced here, in part, by permission of Teachers College, Columbia University, New York City, from whom this and other scales may be secured in any quantity.

(furnished with the test) which translates the actual total score into the standardized pupil score. By reference to other tables the pupil's score may be compared with the grade and age norms, and also be translated into 'reading age' which, divided by the chronological age of the pupil, gives his 'reading quotient.' Thus, a pupil who got twenty-four of the thirty-five questions correct earns a score of fifty-three, which places him in Grade 6B, gives him a reading age of 158, and a reading quotient (supposing him to be eleven years and five months old) of 108. By referring this quotient to the interpreting chart, we find it to fall within the limits of 'high average' (i.e., 105 to 115).

B. Statistical methods

Statistical methods and the teacher. As we have said above, one who proposes to do original research work in educational measurement needs to have some detailed knowledge concerning statistical methods, in order properly to interpret and tabulate results. For the ordinary teacher, however, whose interest in measurement is limited chiefly to the application of tests in her own schoolroom, exhaustive knowledge of such methods is both unnecessary and impractical. At best if she be familiar enough with certain common steps and procedures to handle a batch of forty test papers in arithmetic or silent reading intelligently, and to understand the individual and collective significance of the results, she need not worry over the mathematical processes involved in technical statistical methods: that matter may be safely left with the expert investigator in this field.

In the following pages the writer has attempted to explain and illustrate such of the processes involved in statistical treatment of test results as the teacher should understand, in order to be able to evaluate the data which she herself obtains in her own schoolroom; and also in order to be able to read intelligently the current educational literature, much of which is concerned with the discussion of testing programs and the general theory and practice of measurements.

Scores from an eighth-grade test. As a means of illustrating some of the more fundamental processes in statistical methods with which teachers ought to be familiar, there are herewith presented the data secured by giving the *Thorndike-McCall Reading Scale* to an eighth-grade class of 38 pupils. The scores (T scores), as they were recorded, were as follows:

TABLE XVIII. SCORES RECEIVED BY AN EIGHTH-GRADE CLASS IN READING

59	57	49
59	59	51
59	49	69
49	51	57
59	61	53
57	65	53
53	57	57
53	74	55
69	61	65
74	55	55
61	59	69
65	59	57
55	53	

The first step: rearrangement of the scores. As given above, the scores are arranged according to the alphabetical order of the pupils who received them. Since, mathematically, alphabetical order is obviously of no significance, the first thing to do is to rearrange the scores in descending numerical order. Thus reshuffled, they appear thus:

TABLE XIX. SHOWING THE SCORES OF TABLE XVIII REARRANGED

74	59	57	51
74	59	57	51
69	59	55	49
69	59	55	49
69	59	55	49
65	59	55	
65	59	53	
65	57	53	
61	57	53	
61	57	53	
61	57	53	

The measure of central tendency. Having thus arranged the scores numerically, our next step is to discover what the central tendency of the ability of the class is as determined by this particular test; that is, what is the level of ability represented and toward which the scores all gravitate. There are three methods in common use of determining this level: the *Median*, the *Average*, and the *Mode*. Which of the three methods we shall employ with a given batch of scores is determined by circumstances. If there is a reasonably large number of individual scores, the *Median* will be ordinarily a trustworthy measure of central tendency. If there is a very large number of scores, the *Mode* will often be satisfactory. The *Average* (i.e., the arithmetical mean) is more difficult to compute if the number of scores is large, and it is a very untrustworthy index of central tendency if the scores are one-sided, i.e., if there are many more high than low scores, or vice versa.[1]

a. The Median. The median is the middle score in a series; or, in other words, it is that score above which and below which are exactly one half the scores. Thus the median score in the series presented in Table XIX lies half way between the nineteenth and twentieth scores. Counting back, we find both the nineteenth and twentieth scores to be 57. The median is therefore 57. If there were thirty-seven instead of thirty-eight scores, the median would be the nineteenth, counting from either end.

b. The Mean (or Average). The average of a column of scores is found by adding the sum of the scores and dividing by the number. Mathematically, the formula is ordinarily expressed thus:

$M = \Sigma \frac{m}{n}$, when Σ stands for 'the algebraic sum of,' m for the individual scores, and n their number. Performing this process for the array of scores in Table XIX we have

$$M = \frac{2222}{38} = 58.4$$

c. The Mode. In practice it ordinarily works out that one score appears more times in an array than any other, provided the number of scores is great enough. This typical or representative score is received by several subjects whose performance in the test has been 'central,' while other subjects range rather widely above and below the typical score. The Mode is the score which appears the greatest number of times in the array. Thus, in the scores of Table XIX, the score 59 appears seven times, and is therefore the mode. Other scores appear several times, but 59 appears oftenest. In a larger array the mode score would be still more frequent, since it necessarily represents the commonest condition.

---

[1] Thus, if there are eight hundred citizens in a small town, one of whom — the mill owner — is worth $1,000,000, while the other 799 are worth approximately $500 apiece, the average possessions of each would figure out to be $1750, which would not be a true picture of the typical or 'central' individual in the town.

Frequency surfaces. After an array of scores has been obtained it is desirable to arrange them graphically, in order that we may show their distribution at a glance. For this purpose coördinate paper is necessary. The scores, either grouped in class intervals or in ungrouped integral units, are laid off on the base line (*OX*; see Fig. 13, page 135), and the number of measures are laid off on the vertical axis (*O Y*). Thus, arranging the scores of Table XIX in a frequency polygon, we have a frequency-distribution curve as indicated by Fig. 30.

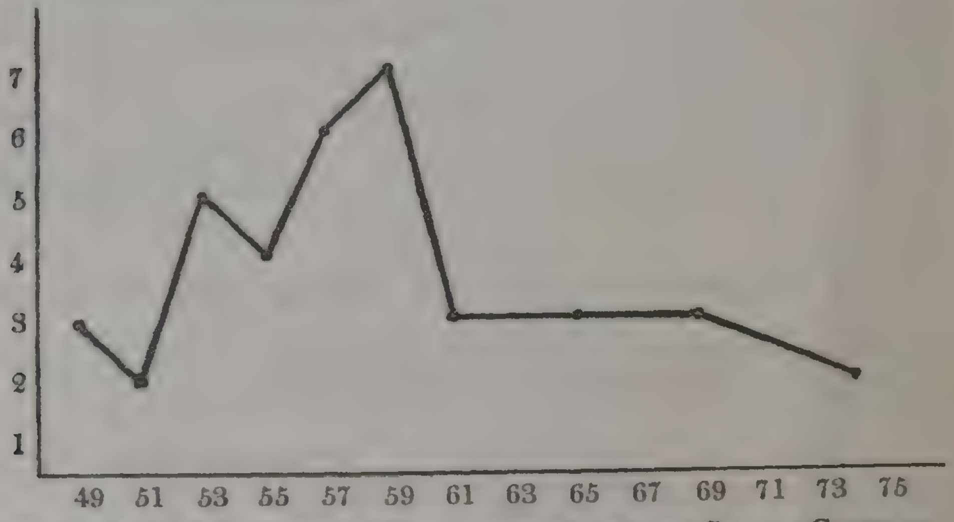


Figure 30. A Frequency Distribution for the Scores Given in Table XIX, in Curve Form

The same data may be plotted in the form of a series of rectangles, so constructed that the base of each rests on Axis *OX*, and extends along it for a distance equal to the length of the class or unit interval; the height of each rectangle will then be determined, along the Axis *OY*, according to the number of measures of a given magnitude. The area of each rectangle will represent the actual number of scores of that particular magnitude represented by its base. Thus, the scores of Table XIX give the 'column' diagram indicated by Fig. 31.

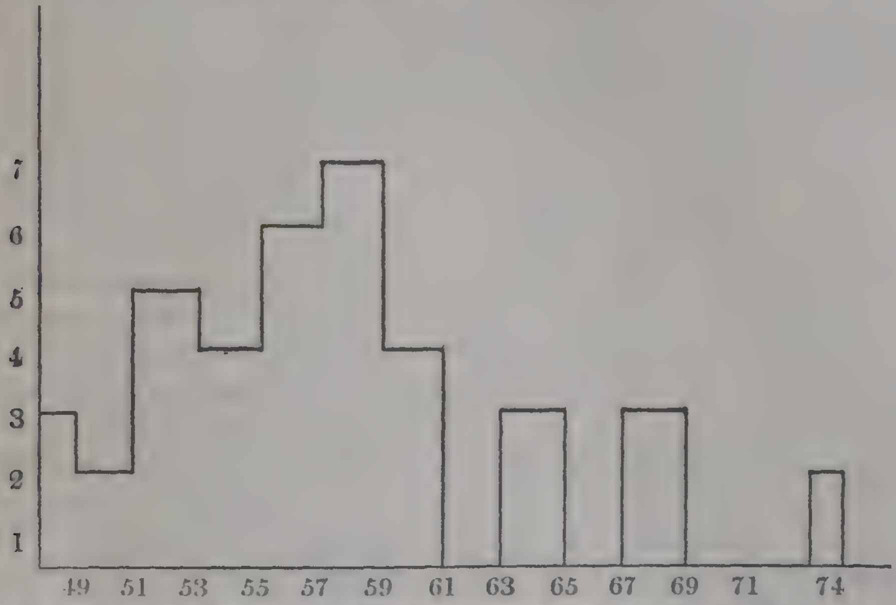


FIGURE 31. A FREQUENCY DISTRIBUTION FOR THE SCORES GIVEN IN TABLE XIX, IN COLUMN FORM

The normal frequency curve. Were there a sufficiently large number of scores in Table XIX — say one thousand or more — instead of the irregular and unsymmetrical curve represented in Fig. 31 we should have a perfectly smooth and regular one, similar to that shown in Fig. 32, the reason being that presumably every ability which can be measured is evenly distributed among people. The greatest number of persons will have a median rank in any given trait, X; and for every individual who has one degree less of X there is a corresponding individual who has one degree more of X; and so with individuals possessing two or ten or fifty or n degrees less: if we include a sufficient number of such individuals in our study we shall find them balanced by those who possess two or ten or fifty or n degrees more of X. The only condition is that a large enough group of people be included in the scores. The curve which represents such a symmetry of distribution is known as a *normal frequency surface*, or a *normal surface of distribution*. This type of curve is shown in Fig. 32.

The curves in Figs. 30 and 31 represent integral measures; that is, ungrouped scores exactly as they appear in the array. When, however, there is a large number of scores to be tabulated graphically, many of which occur several times, a simpler curve can be constructed than that in which each score must appear as a separate unit and occupy a definite position. Such a curve is constructed by dividing the scores into class intervals of a size determined upon. Exactly what the magnitude of an interval shall be in tabulating a given series of scores depends upon the character of the distribution. In general, the class interval must be of fitting size to indicate clearly the distinct changes in the distribution of the scores from one level to another. The following array of scores, rearranged in descending numerical order, represents the result of an achievement test in reading[1] given to 83 fourth-grade children.

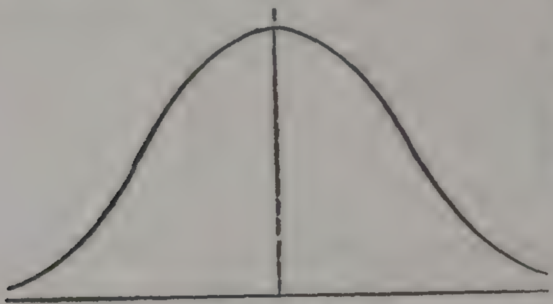


FIGURE 32.

TABLE XX. SCORES MADE IN AN ACHIEVEMENT TEST IN READING

55	50	47	44	43	41	39	38
54	49	46	44	42	40	39	37
53	48	46	44	42	40	39	37
53	48	46	44	42	40	39	37
51	48	45	44	42	40	39	36
51	48	45	43	41	40	39	36
51	47	45	43	41	40	39	36
51	47	45	43	41	40	38	36
50	47	44	43	41	39	38	35
50	47	44	43	41	39	38	33
							33

Using class-intervals of 3 units, these scores group themselves into the following frequencies:

---

[1] *Thorndike-McCall Reading Scale.*

TABLE XXI. SHOWING FREQUENCY DISTRIBUTION OF SCORES IN TABLE XX. (3 UNIT INTERVALS)

Scores	*Number of Pupils*
54–56	2
51–53	6
48–50	8
45–47	12
42–44	17
39–41	24
36–38	11
33–35	3
	Total 83

Constructing a distribution polygon from these data, using always the units of the frequency distribution on the base line *OX*, and the number of pupils receiving such units on the vertical line, *OY*, we have the curve represented in Fig. 33.

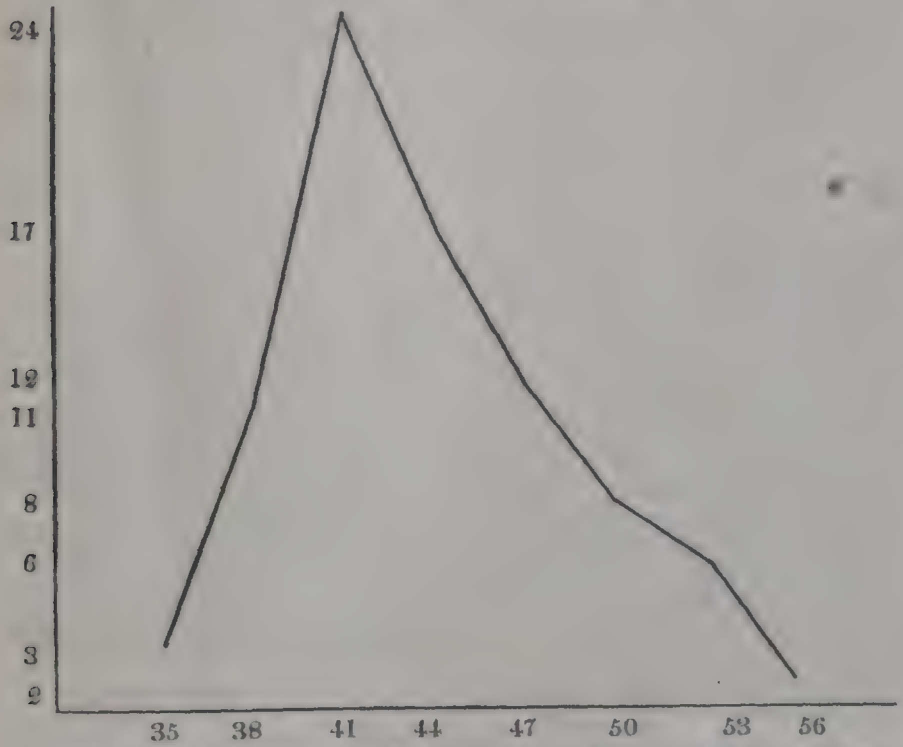


FIGURE 33. A DISTRIBUTION POLYGON WITH GROUPED FREQUENCIES

Measures of variability. When we have found the *central tendency* of an array of scores (i.e., the median, mean, or mode) we have obtained the representative or common level of that ability or trait which the scores express. We do not know, however, how slight or considerable is the variation of the individual scores from the central score; that is, we are uncertain as to the closeness with which they are grouped about the average or median.[1] In order to comprehend exactly how close the score of a given individual is to the representative score, or how far removed it is from it, we need to apply some means of measuring the amount of this variability. There are three measures of variability in common use; they are: the *Average Deviation* (*A.D.*), *Standard Deviation* (*S.D.*) and *Probable Error* (*P.E.*)

a. The Average Deviation. In order to find the average deviation of a group of scores, it is first necessary to find the individual deviations of the scores from the central score (usually the median). This is done by finding the difference between each score in the array and the median score. Those scores that are higher than the median score are said to have a positive deviation, and are given the + sign; those that are lower are said to have a negative deviation, and are written with the – sign. The sum total of the individual deviations, without regard to sign, divided by the number of scores in the array,[2] gives the A.D. We may express this rule in terms of the formula:

$$A.D. = \frac{\Sigma d}{n} \text{ or } \frac{\Sigma d}{n-1}$$

when d stands for the individual deviations, and n for the number

---

[1] The importance of knowing the amount of variation of the several scores from the central tendency may be illustrated by an analogy from the weather. Thus, the temperature for the month of March might vary between the extremes of 58° above zero and 10° below zero, and yet the mean temperature be 38°. In March of the next year, the variation might conceivably be between 20° above zero and 40° above zero, with the mean temperature for the month at 38°. So far as an inspection of the mean temperature for the month is concerned, there would be no way of knowing whether the temperature for either year was reasonably uniform. So with an array of scores: we can make out their homogeneity or their heterogeneity only by computing the amount of their deviation from the mean (or median).

[2] For a small number of scores the formula is ordinarily written

$$\frac{\Sigma d}{n-1} \text{ instead of } \frac{\Sigma d}{n}$$

of scores in the array. Table XXII illustrates the method of computing the average deviation of a series of scores. The array used is that presented in Table XIX.

b. The Standard Deviation. Measurement of the variability of scores by means of the method of standard deviation involves several more steps than is the case with the method of average deviation. It is believed by statisticians to be somewhat more accurate, and is very extensively employed by them. It is computed by extracting the square root of the average of the squares of the individual deviations. Before the S.D. can be computed, therefore, it is necessary to work out the individual deviations, as in the computation of the average deviation. The formula for finding the S.D.[1] may be expressed thus:

$$\text{S.D.} = \sqrt{\frac{\Sigma\,(d)^2}{n-1}}$$

Table XXIII illustrates the application of this formula to the data represented in Table XXII.

In a normal distribution σ will be found to be somewhat larger than A.D., the relation being constant at

$$\sigma = 1.2533 \text{ A.D.}$$

or

$$A.D. = 0.7979\,\sigma$$

c. Probable Error. The third measure commonly employed to determine the variability of an array of scores is known as the Probable Error.[2] This is by far the easiest of the three measures to compute, and is used very extensively with educational data of every type. In practice, the Probable Error is readily determined by halving the difference between the 25-percentile and the 75-percentile. Counting back from the lowest score exactly one fourth the total number we arrive at the 25-percentile; counting back from the highest score one fourth the total number, we arrive at the 75-percentile. Half the difference between these two scores

---

[1] The symbol for S.D. ordinarily used in tabulation is σ, and is read 'sigma.'

[2] Strictly speaking the Probable Error should be called the *Quartiel Deviation*, the former term being properly reserved for scores symmetrically arranged (and not skewed) on the probability curve. Inasmuch, however, as the P.E. is commonly employed in connection with educational data to mean the same as quartile deviation, we shall so employ it in this discussion.

TABLE XXII. ILLUSTRATING THE METHOD OF FINDING THE A.D.

Scores	*Deviations*
74	+ 17
74	+ 17
69	+ 12
69	+ 12
69	+ 12
65	+ 8
65	+ 8
65	+ 8
61	+ 4
61	+ 4
61	+ 4
59	+ 2
59	+ 2
59	+ 2
59	+ 2
59	+ 2
59	+ 2
59	+ 2
57	0
57 Median	0
57	0
57	0
57	0
57	0
55	− 2
55	− 2
55	− 2
55	− 2
53	− 4
53	− 4
53	− 4
53	− 4
53	− 4
51	− 6
51	− 6
49	− 8
49	− 8
49	− 8

$$\text{A.D.} = \frac{184}{37} = 4.97$$

TABLE XXIII. ILLUSTRATING THE METHOD OF FINDING σ

Score	*d*	d^2
74	+ 17	289
74	+ 17	289
69	+ 12	144
69	+ 12	144
69	+ 12	144
65	+ 8	64
65	+ 8	64
65	+ 8	64
61	+ 4	16
61	+ 4	16
61	+ 4	16
59	+ 2	4
59	+ 2	4
59	+ 2	4
59	+ 2	4
59	+ 2	4
59	+ 2	4
59	+ 2	4
57	0	0
57	0	0
57	0	0
57	0	0
57	0	0
57	0	0
55	− 2	4
55	− 2	4
55	− 2	4
55	− 2	4
53	− 4	16
53	− 4	16
53	− 4	16
53	− 4	16
53	− 4	16
51	− 6	36
51	− 6	36
49	− 8	64
49	− 8	64
49	− 8	64
Sums	184	1638
Average	4.97	44.27

$$\sigma = \sqrt{\frac{1638}{37}}$$

$$= \sqrt{44.27}$$

$$= \quad 6.65$$

represents the P.E. This rule may be expressed in the formula thus:

$$P.E. = \frac{M\frac{3}{4}n - M\frac{1}{4}n}{2}$$

Referring back to the array of scores given in Table XXIII, we find the ninth and one half score from the lowest to be 53, and from the highest to be 61. Applying the formula, we have:

$$P.E. = \frac{61 - 53}{2} = 4.00$$

In a normal distribution, after we have found either the A.D. or the S.D., we may compute the P.E. by one or the other of the following formulæ:

$$P.E. = 0.6745 \quad S.D.$$

or

$$P.E. = 0.8453 \quad A.D.$$

The several measures of the variability of scores presented in Table XXIII may now be summarized, thus:

$$A.D. = 4.97$$
$$S.D. = 6.65$$
$$P.E. = 4.00$$

Any one of these may be considered to represent reasonably accurately the variability or the tendency to deviation of the several scores from the central tendency, which is 57.

Measures of correlation. Thus far we have been discussing central tendency and deviation of scores. There remains one other important mathematical procedure in the statistical treatment of educational data: the determination of the *coefficient of correlation.* In the preceding half dozen pages we have been making illustrative use of an array of thirty-eight scores, achieved by an eighth-grade class in reading on the basis of the *Thorndike-McCall Reading Scale.* Each one of the thirty-eight pupils received a definite score for his reading efficiency as judged by this particular test. The pupil who stood highest received 74; the poorest received 49; the middle received 57. But where would the pupil who got the highest score in reading rank in arithmetic, or in writing, or in any or all the other subjects in the curriculum? Where would the pupil who was poorest in reading rank in these other subjects? Would the middle pupil in reading score mid-way also in them? These questions suggest the meaning of the term *correlation*, by which is meant the relation that exists between two functions. If the best pupils in English are found to stand among the best pupils in arithmetic, for example, we say there is a high positive correlation between ability in these two subjects; if the poorest pupils rank similarly with the poorest, and the middle with the middle, we say again, there is a high positive correlation between ability in these subjects. In other words, when existence of one trait is accompanied invariably by existence of another trait in reasonably equivalent amounts, the correlation is a positive one. If, on the other hand, it should develop that those pupils who rank highest in reading rank lowest in arithmetic, the correlation is said to be negative. In other words, when two traits tend to be mutually exclusive, the correlation is a negative one.

Theoretically, at least, there are all degrees of positive and negative correlation, ranging from -1.00 (perfect negative correlation), through zero (no constant relationship), to $+1.00$ (perfect positive correlation). The symbol r is used to express the exact degree of relationship, and symbolizes therefore the *coefficient of correlation*. In general it may be said that when $r =$ between $-.30$ and $+.30$, no significant correlation exists; when r is greater than $+.30$ the correlation thus expressed is of significance, becoming relatively more so as r approaches $+1.00$, which it rarely if ever reaches owing to the inexactitude of diagnostic measurements and the inequalities of achievement.

Of the several formulæ in common use for computing r, the one most generally employed appears to be that of Pearson, which may be stated as follows:

$$r = \frac{\Sigma XY}{n\sigma_1\sigma_2}$$

in which X represents the individual deviations in one function,
Y represents the individual deviations in the other function,
n represents the number of scores in either case,
σ_1 represents the S.D. of the first array,
σ_2 represents the S.D. of the second array.

Correlation between reading and arithmetic scores received by an eighth-grade class. In order to illustrate the application of the Pearson formula there are presented in Table XXIV the steps in determining the coefficient of correlation between the scores received by an eighth-grade class of thirty-three pupils in reading and arithmetic. The reading scores are those presented in Table

TABLE XXIV. ILLUSTRATING THE COMPUTATION OF r BY THE PEARSON FORMULA

1 Pupil	2 Score in Arithmetic	3 Indiv. Deviations	4 Square of Deviations	5 Score in Reading	6 Indiv. Deviations	7 Square of Deviations	8 + Products	9 − Products
1 A.A.	71	− 4	16	59	+ 2	4		− 8
2 J.B.	69	− 6	36	59	+ 2	4		−12
3 C.C.	71	− 4	16	59	+ 2	4		− 8
4 R.C.	67	− 8	64	49	− 8	64	+ 64	
5 R.H.	71	− 4	16	59	+ 2	4		− 8
6 A.L.	83	+ 8	64	57	0	0	0	0
7 E.M.	67	− 8	64	53	− 4	16	+32	
8 H.M.	65	−10	100	53	− 4	16	+40	
9 J.N.	85	+10	100	69	+12	144	+120	
10 G.R.	87	+12	144	74	+17	289	+204	
11 T.T.	81	+ 6	36	65	+ 8	64	+48	
12 F.S.	77	+ 2	4	61	+ 4	16	+ 8	
13 C.B.	83	+ 8	64	57	0	0	0	0
14 D.C.	61	−14	196	49	− 8	64	+112	
15 S.F.	71	− 4	16	51	− 6	36	+24	
16								
17 H.H.	69	− 6	36	65	+ 8	64		−48
18 P.H.	79	+ 4	16	57	0	0	0	0
19 F.G.	71	− 4	16	74	+17	289		−68
20 P.K.	81	+ 6	36	61	+ 4	16	+24	
21 L.L.	71	− 4	16	55	− 2	4	+ 8	
22 L.S.	75	0	0	59	+ 2	4	0	0
23 W.L.	77	+ 2	4	59	+ 2	4	+ 4	
24 L.K.	81	+ 6	36	53	− 4	16		−24
25 J.L.	67	− 8	64	49	− 8	64	+64	
26 D.M.	77	+ 2	4	51	− 6	36		−12
27 J.M.	69	− 6	36	69	+12	144		−72
28 G.R.	80	+ 5	25	57	0	0	0	0
29 G.S.	81	+ 6	36	53	− 4	16		−24
30 G.T.	86	+11	121	55	− 2	4		−22
31 E.T.	75	0	0	65	+ 8	64	0	0
32 R.W.	86	+11	121	55	− 2	4		−22
33 H.W.	84	+ 9	81	69	+12	144	+108	
34 K.Y.	69	− 6	36	57	0	0	0	0
Median	75			57				
Totals			1620			1598	860	328
S.D.			7.00			6.96		

$r = 0.33$

XXII, except that five of the thirty-eight pupils did not take the arithmetic test; hence only those thirty-three scores are included which were common to both. The scale used in the arithmetic test was the *Buckingham Scale for Problems in Arithmetic.*

In the table the x deviations are given in column 3, the y deviations in column 6. Applying the formula as given above for computing the coefficient of correlation, we have

$$r = \frac{860 - 328}{33 \times 7.00 \times 6.96} = 0.33$$

Our tabulation, then, reveals the fact that, so far as these thirty-three eighth-grade pupils are concerned, ability in arithmetic (as indicated by achievement in the *Buckingham Scale*) and ability in reading (as indicated by achievement in the *Thorndike-McCall Scale*) correlate with one another at 0.33. This suggests a slight positive correlation, although it is not sufficiently high to be of any significance.[1]

QUESTIONS AND PROBLEMS

1. The history and present scope of achievement testing.
2. 'Skewed' and 'smoothed' curves.
3. The unreliability of the average as a measure of central tendency.
4. Look up in the current educational literature and report upon some article in which the statistical methods discussed in this lesson are concretely applied.

SELECTED REFERENCES

1. McCall, Wm. A. *How to Measure in Education.* (For general reference.)

---

[1] For the same reason that some measure of variability (S.D., A.D., or P.E.) for the scores in an array is helpful, it is frequently valuable to obtain the P.E. of a correlation. The formula for this is:

$$P.E. = .6745 \frac{1 - r^2}{\sqrt{n}}$$

Working out the probable error of r as computed for abilities in arithmetic and reading, above, we have

$$P.E. = .6745 \frac{1 - .1089}{5.74} = .10$$

To be of any striking significance r must always be at least three times its P.E.

2. Monroe, W. S., DeVoss, J. C., and Kelly, F. J. *Educational Tests and Measurements*, chapters 1, 8, 9, 10.
3 Monroe, W. S. *Introduction to Educational Measurements.* (For general reference.)
4. Pyle, W. H. *The Psychology of Learning*, chapter 14.
5. Rugg, H. O. *Statistical Methods Applied to Education.* Especially chapters 4–9.
6. Starch, D. *Educational Measurements*, chapters 1 and 2.

INDEX

Abilities in school subjects, correlation of, 257, 264.
Ability to learn, general, 258; to perceive relationships, 268.
Abscissa, defined, 135.
Absence of language, as a handicap in animal learning, 124.
Abstract *versus* concrete materials, 280.
Accuracy, as an element in economical performance, 74.
Achievement tests, 396.
Acquisition, of knowledge as a goal in learning, 86; of skill in typewriting, 147; rate and duration of, 302; variation in rate of, 134.
Activity, thirst for, 7.
Adaptation to stimuli, 54.
Adjustment to the school environment, 378.
Adult and child memory compared, 339.
Affection and the learning process, 46.
Affective experience, effect of, upon the organism, 385.
Age, a factor in retentivity, 306.
Aim of the educative process, 62.
Anabolism, 272.
Analogy, law of, 120.
Analysis, in perception building, 168.
Angell, F., 354.
Angell, J. R., 58, 238.
Animal and human learning compared, 114; contrasted, 122.
Animal experimentation, technique of, 105.
Animal learner, inability of, to abstract, 124.
Animal learning, classified, 82; curve of, 128; imagination and, 120; in general, 101.
Annoyance, 42.
Apperceptive consciousness, 172.
Approbation, thirst for, 7.
Arbitrary association, 202.
Arithmetic, two lessons in, contrasted, 48.
Assimilation, law of, 120.
Association, arbitrary and logical, 202; as related to habit, 212; by similarity, 190; determining factors in, 187; experiment in, 180; faithfully performed by nervous system, 185; illustrated, 184; law of, 186; meaning of, 182; number of, a factor in retention, 311; organization of, a factor in retention, 312; tests, 179; peculiarities of, 337.
Association series, rise of new, 192.
Associations, building of, 87.
Associative learning, 202 ff.; classified, 82; in animals, 123; in general, 179 ff.
Attention, as a selecting and neglecting function, 231; as basal factor in habit formation and knowledge building, 296; as related to interest, 148; as related to mental attitude, 255, 257.
Attention, arousal of, by a changing series, 289; by knowledge of the goal, 293; by meaningful materials, 290; by novel series, 291; by possession of a plan or formula, 295; by related datum, 285.
Attention, as conditioned by absence of distraction, 254; by efficient sense organs, 250; by optimum temperature and humidity, 252; by exercise, 253; by feeling attitude, 237 ff.; by general health, 249; by good seating, 253; by proper lighting, 252.
Attention, derived, 244; duration of, 289; effect of fatigue upon, 258; evolution of, in the child, 242; external helps to, 251; forced, 230, 237 ff., 240; free, 230, 238 ff.; im-

mediate, 244; internal helps to, 249 ff.; non-voluntary, 239; physical helps and hindrances to, 249 ff.; psychology of, 280 ff.; range of, 231; rôle played by, in development of skill, 83; spontaneous, 239; under distraction, 230; unvoluntary, 239.
Attitude, changes of, in achievement of skill, 77; principle of, in association, 190.
Auditory ideation, 328.
'Aussage' method, 164.
Automatic action, control of, by nervous system, 72.
Automatization, 338.
Autonomic nervous system, relation of, to lower level responses, 72.
Average, as a measure of central tendency, 403.
Average deviation, as a measure of variability, 408.
Awareness of problem, 225.

Bagley, W. C., 58, 246, 256.
Bair, J. H., 115.
Ball-tossing experiments, 156.
Bennett, C. J. C., 356.
Berry on imitative learning in cats and rats, 127.
Betts, G. H., 234, 264.
Bingham, W. V., 304.
Bolton on improvability of memory, 333.
Bonds, formation of neuro-muscular, 67; part played by, in associative learning, 182.
Book, W. F., 128, 147 ff.
'Breathing places' in learning, 149.
Breese, B. B., 100, 318, 344.
Briggs, T. H., 354.
Brightness, discrimination of, 153.
Bruner, F. G., 170.
Bryan, W. L., 146.
Burnham, W. H., 163, 252, 385.

Calisthenics, importance of, 254.
Cancellation test, 155.
Cannon, W. B., 384.
Capacity to learn, variation in, 304.
Card-sorting, 61.
Carpenter, W. B., 309.
Carr, H. A., 115.
Carter, R. E., 392.
Central nervous system, lower level controls in, 72.
Central tendency, measures of, 402 ff.
Change in type of activity, effect of, upon fatigue, 274.
Charcot, J. M., 327.
Charters, W. W., 37.
Chess-playing, study of, 214; mental qualities utilized in, 215.
Child, evolution of attention in, 242.
Child mind, natural immaturity of, 236.
Children's memory, compared with adults', 339; efficiency of, 340.
Cleveland, A. A., 214.
Coefficient of correlation, 413.
Cole on imitative learning in raccoons, 127.
Collecting, thirst for, 7.
Color discrimination cards, 153.
Colorless lessons, 54.
Colvin, S. S., 17, 100, 375.
Combination of ideational types, 327.
Comenius, 197.
Companionship, thirst for, 7.
Comparative psychology, problems of, 103 ff.
Comparison, in inductive teaching, 222.
Concentration, effect of fatigue upon, 258.
Conceptual knowledge, 297.
Concrete ideation, 327 ff.
Concrete *versus* abstract materials, 280.
Conditioning factors in learning, 270.
Confidence, growth of, with practice, 78.
Consciousness, rôle played by, in development of skill, 83.
Control group, 358.
Controlled association experiment, 180.
Coover, J. E., 354.
Corporal punishment, as a negative incentive, 246.
Correlation, of abilities, 264; measures of, 412.
'Cramming,' 336.

'Critical stage' in the plateau, 149.
Curricular subjects, 'fatigue coefficients' of, 276.
Curve constructing, 130 ff.
Curves, general value of, 131 ff.; rising *versus* falling, 138; use of, in learning, 134, 141.

Daily practice curve, nature of, 149.
Dearborn, W. F., 333.
Deduction, as a fifth formal step, 224.
Deductive learning process, four steps in, 225 ff.
Deductive reasoning, 219 ff.
Defective sense organs and attention, 251.
De Guimps, R., 197.
Delayed reproduction, method of, 303.
Delayedness of instincts, 11.
Deprivation of privileges, as negative incentive, 247.
Derived attention, 244.
DeVoss, J. C., 396, 416.
Dewey, J., 98, 116, 229, 248.
Digit-symbol substitution, 136 ff.
Discrimination, auditory, 169; of brightness, 153; of weight, 154; individual differences in, 169 ff.
Distraction, absence of, important for attention, 254; attention under, 230.
Distribution of trials, 118.
Distribution polygon, 407.
Disuse, as a method of modifying original responses, 14.
Diurnal variations in efficiency, 276.
Dowling, D. J., 178.
Dramatization, thirst for, 7.
Drill periods, 148.
Drudgery, conception of work as, disastrous, 241.
Duration of acquisition, 302.
Dynamo-genesis, law of, 89.
Dynamometer, 116.

Earhart, L. B., 228, 229.
Ears, learning to move, 115.
Ebbinghaus, H., 312 ff.; 341.
Economy of performance based upon neural bonds, 74.
Educational measurement, 392 ff.
Educational method not static, 211.
Educative process, aim of, 62.
Efficiency, diurnal variations in, 276.
Efficient sense organs, importance of, 250.
Effort, as related to interest, 148.
Einfühlung, 329.
Elliott, E. C., 393.
Émile, 196.
Encouragement, a secondary condition of skill, 163.
Enthusiasm in practice, 149.
Excellence, thirst for, 7.
Experimentation, animal, 105 ff.
Experiments in transference of training, 353 ff.

Faculty psychology, 350 ff.
Failure, effect of, upon learner, 163.
Fatigue, coefficients, 276; effect of, on concentration, 258; on learning, 271; meaning of, 271; methods of measuring, 273; minimum of, in bonded nerve routes, 75; toxins, 272; experiments upon, by Kraepelin, Landois, Mosso, Ranke, Verworn and Weichardt, 272.
Fear, as a negative incentive, 246.
Feeling accompaniment of adult responses, 39; of children's responses, 43.
Feeling attitudes, formation of, 56; in attention, 236.
Feeling by-products of the schoolroom situation, 55.
Feelings, as related to personality, 383; importance of arousing, 47; part played by, in the learning process, 46 ff.
Fidelity of report, 164.
First experience with a typewriter, 64.
Forced attention, 230; 237 ff.
Forgetting, excessive, 326; importance of, 320; individual differences in rate of, 324; rate of, 319.
Formal discipline, general conclusions concerning, 374; opponents of, 373; proponents of, 373.
Formal steps in induction, 221.
Formal training, 347 ff.

Free-association experiments, 81.
Free attention, 230; 238 ff.
Free ideas, 122.
Freeman, F. N., 178, 229, 344.
Freeman's puzzle-box, 102.
Free-rising ideas, 338.
Frequency, principle of, 188.
Frequency surfaces, 404.
Freudians, 388.

General health of the organism, a condition of attention, 249.
General nature of learning capacity, 258.
General principles, inability of animals to abstract, 124.
Generalization, in inductive teaching, 222.
'Getting' a lesson, 209.
Goals in learning, 81 ff.
Gordon, K., 58, 303, 304, 318.
Grades as incentives, 247.

Haberle, schoolmaster of Germany, 246.
Habit, as a goal in learning, 82 ff.; similar to association, 212; to memory, 301.
Habit-arcs, building of, 117.
Habits, of attention, common lack of, 235; process of forming motor, 111.
Habitual and ideational responses, distinction between, 212.
Hall, G. S., 246.
Hampton Court Maze, 107, 117.
Harter, N., 146.
Health, a condition of attention, 249.
Healy's puzzle-box, 102.
Henderson on formal discipline, 351.
Heraclitus, 288.
Herbart, 350.
Hewins, N. P., 372, 375.
Hicks, V. C., 115.
'Higher order' habits, 147.
Hobhouse on imitative learning in monkeys, 127.
Hocking, A., 278.
Hollingworth, H. L., 264.
Holmes, M. E., 254, 275.
Horne, H. H., 256.
Human learning, classified, 82; compared with animal, 114.
Humidity, as affecting attention, 252.
Hygiene of program, 276.
Hypothesis in deductive learning, 226.

Idea and knowledge, 194.
Idea systems, building of, 200.
Ideas, non-retention of, by animals, 122.
Ideational types, 327 ff.
Identical elements, in transference, 355, 371 ff.; of substance, procedure, and aim, 372.
Ideo-motor action, 85.
Illumination of rooms, 252.
Image type, determination of, 331; training of, 331.
Imitative learning, absence of, in animals, 126 ff.; classified, 82; in human beings, 128.
Immaterial rewards, as positive incentives, 247.
Immaturity of the child mind, 236.
Immediate attention, 244; free attention, 245.
Importance of over-learning, 323.
Impressing the data, the initial phase of learning, 229 ff.; 257 ff.
Inaccuracy of teachers' marks, 392.
Incentive as related to the learning process, 115.
Incentives, classified, 246; defined, 246; negative, 246; positive, 247.
Index of intelligence, 122.
Individual differences, in discrimination, 169; in problem-solving, 216; in rate of forgetting, 324.
Induction, formal steps in, 221 ff.
Inductive lesson, advantages and disadvantages of, 223.
Inductive reasoning, 219 ff.
Ingenuity test, 180.
Inglis, A., 394.
Inhibited movements, fatigue in performing, 76.
Initial phase of learning, 230; 257 ff.
Initial trials, time element in, 117.
Instinct, urge of, 3.
Instinctive response, some important forms of, 6.

Instinctive urge, as nature's cardinal motivation, 8.

Instincts, as great mainsprings of action, 3; as racial heritage, 10; bearing of, upon schoolroom motivation, 19; can the energy of, be harnessed? 5; close interrelationship of, 7; delayedness of, 11; in animals, 131; modifiability of, 8, 13; transitoriness of, 12.

Intellect and personality, 381.

Intelligence, correlation of memory with, 300.

Intensity, principle of, 189.

Intercorrelation between learning types, 260 ff.

Interest, and attention, 148; as a secondary condition of skill, 161; importance of, in problem-solving, 228; principle of, as upheld by Dewey, 248.

Investigation, thirst for, 7.

Iteration, 338.

James, W., 237, 238, 310, 318, 332.

Jastrow, J., 82.

Judd, C. H., 168, 172, 178, 192, 350.

Katabolism, 271.

Kelly, F. J., 396, 416.

Kilpatrick, W. H., 37, 57.

Kirkpatrick, E. A., 229.

Knowledge, a relative term, 92; and idea, 194; as a goal in learning, 81, 86 ff; function of, 91; progressive, 92.

Laboratory studies of perception, 175.

Labyrinth puzzle, Tait's, 103.

Language, absence of, in animals a handicap in learning, 124.

LaRue, D. W., 229, 386, 389, 390.

Law of analogy, 120; of assimilation, 120; of readiness, 114.

Learning, as bond connecting, 180; associative, 179 ff; conditional factors in, 270; fatigue as a factor in, 271; initial phase of, 230, 257; logical, 206; of relationships, 95; methods of, 299; not synonymous with memory, 341; perceptual, 153 ff.; sensori-motor, 153 ff.; variation in quality of, 305.

Learning capacity, effect of fatigue upon, 257 ff.; evidence of general, 259; general rather than specific, 258; tests of, 281.

Learning curve, construction of, 135 ff.; general nature of, 149; general treatment, 130 ff.; practical value of, 141; use of, 134.

Learning process, a never-ending process, 79; as consisting of habit-arcs, 117; as illustrated in the telegraphic code, 146 ff.; classification of, 82; incentive and, 115; in general, 61 ff.; meaning of, 62; mental hygiene and, 397; personality and, 376 ff.; physiological basis of, 67; pleasurable accompaniments of, 47; results of, 70; two goals in, 81.

Le Conte on the secretions, 384.

Lecture method criticized, 222.

Leibnitz on thinking, 329.

Lennes, N. J., 348.

Lesson periods, length of, 278.

Leuba, J. H., 147.

Lighting, importance of good, 252.

Locke, 197.

Logical association, 202.

Logical learning illustrated, 206.

Logical memory, tests of, 284, 298, 363, 366.

Lunt, J. R., 24.

Lyon, D. O., 301, 303, 341.

MacPhail, A. H., 282.

Maladjustment to the school environment, 378.

Malnutrition, as affecting attention, 250.

Marks, as incentives, 247; studies of, 392.

Maturity, as a factor in retentivity, 306.

Maze experimentation, 107.

McCall, W. A., 415.

McClure, W., 20.

McMurry, F. M., 209, 342, 390.

Mean, as a measure of central tendency, 403.

Meaning, 92, 96, 205.

Meaningful *versus* nonsense materials, 280.
Meaningless definitions, 198.
Measurement of results of learning, 391 ff.
Measures, of central tendency, 402 ff.; of correlation, 412; of variability, 408.
Mechanical puzzles, manipulation of, 123.
Median, as a measure of central tendency, 403.
Memorial efficiency of children, 340.
Memories, not memory, 316; children's and adults' compared, 339.
Memorizing, as confused with studying, 209; as following thinking, 210; not synonymous with learning, 341.
Memory, and habit, 301; and memories, 298 ff.; chronological, 309; classified, according to arrangement of data in the mind, 308; according to methods used in impressing the data, 307; according to rate and duration of acquisition, 302; correlation of, with intelligence, 300; desultory, 309; improvement of, 332; logical, 309; not a general capacity, 316; pedagogical applications of the psychology of, 339.
Memory systems, 335.
Mental attitude, a factor in attention, 255; in motivation, 38 ff.
Mental hygiene, and the learning process, 377; and reëducation, 382; and the teacher, 379.
Metabolic processes, 271.
Method, of continuous work, 273; of delayed reproduction, 303; of presentation, 330; learning process classified according to, 82; meaning of, 57.
Meumann, E., 80, 264, 320, 330, 338, 344.
Miller, H. C., 378, 383, 390.
Milne's *Standard Arithmetic*, 51.
Mirror-drawing experiment, 101, 118.
Mode, as a measure of central tendency, 403.
Modern schools *versus* older schools, 293.
Modifiability of instinct, 13 ff.
Modification of neuro-muscular bonds, 70.
Monroe Arithmetic Scale, 398.
Monroe, W. S., 396, 416.
Montessori schools, 171.
Mood, principle of, in association, 190.
Motivation, and the teacher, 27; characteristics of genuine, 27; importance of in human behavior, 18; in problem-solving, 228; lack of adequate, 55; limitations of, 34; mental attitude an important factor in, 38 ff.; of general science, 24; of history, 29 ff.; of learning, 3 ff.; of schoolroom tasks, 46; real meaning of, in school work, 26; significance of, 18 ff.
Motives, bearing of, upon the schoolroom situation, 19; enumeration of, 19; selfish and unselfish, 18; supplying of, for all subjects of the curriculum, 32.
Motor habits, process of forming, 111; trial and error in formation of, 114.
Motor ideation, 328 ff.
Multiple response, 113.
Murphy, H. H., 119.

Nagging, evils of, 246.
Native capacity to learn, 304.
Need, as stimulus to reason, 217.
Needs, personal *versus* social, 218.
Negative incentives, 246.
Neglecting function of attention, 233.
Nerve connections or bonds, 68.
Nervous system, relation of, to instinctive reaction, 72.
Neural bonds, and fatigue, 75; and subjective changes of attitude, 77.
Neural pathways and economy of performance, 74.
Neuro-muscular bonds, modification of, 70; as second nature, 70.
Neutral feeling zone, 44.
New association series, rise of, 192.
New situations, response to, 119.

Nomadic adventure, thirst for, 7.
Nonsense syllables, construction of, 203; learning of, 179; *versus* meaningful materials, 280.
Normal frequency curve, 405.
Norsworthy, N., 12, 17, 100, 229, 256, 303, 318.
Novelty, as a stimulant of free attention, 214.

Objective teaching, 198.
Observation, 164.
Oechsler on the secretions, 384.
Offner, M., 256, 273.
'Opposites' test, 180, 363, 366.
Optimum distribution of trials, 118.
Ordinate defined, 135.
Organization of associations, 312; illustrated, 314 ff.
Original nature, some characteristics of, 9; some methods of modifying, 14 ff.
O'Shea, M. V., 375.
Over-learning, importance of, 323.

Panama Canal project, 20 ff.
Parker, S. C., 196.
Part method of learning, 299, 307.
Peculiarities of association, 337.
Perception building, 173.
Perception, laboratory studies of, 175.
Perceptual experience, importance of rich, 195.
Perceptual knowledge-building, 168.
Perceptual learning, 164 ff.; classified, 82; full meaning of, 177.
Perseveration, 338.
Persistence, 338.
Personality, and feeling, 383; and intellect, 381; and volition, 386; as related to the learning process, 376; building of, 376.
Pestalozzi, 197.
Physiological basis of the learning process, 67.
Pied material in perception testing, 176.
Plateau phenomenon, absence of, in animal learning, 128; as interpreted by Bryan and Harter, 146; general discussion of, 143; significance of, 146.
Play, as illustrative of free attention, 239; thirst for, 7.
Pleasurable accompaniments of learning process, 47.
Porter on imitative learning in birds, 127.
Positive incentives, 247.
Positivism as a foundation of mental health, 380.
Possession, thirst for, 7.
Practice group, 358.
Preferential neural pathways, 9.
Preparation, in inductive teaching, 221.
Presentation, in inductive teaching, 221.
Primacy, principle of, 188.
Principle of interest, 248.
Principles of learning, violation of, 326.
Prizes, as doubtful incentives, 247.
Probable error, as a measure of variability, 409.
Problem, awareness of, as first step in deduction, 225.
Problem attitude, 116.
Problems, as stimulating effort, 97, 199, 219; methods of solving, 219.
Problem-solving, 202 ff.; 213.
Problem-solving methods, studies in, 214 ff.
Progressive knowledge, 92.
Project, illustration of, from the eighth grade, 20.
Psycho-analytic school, 388.
Psychology of attention, some pedagogic inferences from, 285.
Punishment as a means of modifying original nature, 14.
Puzzle-box experiments, 120, 105; Healy's, 102.
Puzzles, manipulation of, 123, 214.
Pyle, W. H., 80, 100, 152, 229, 255, 260, 284, 301, 318, 333, 344, 375, 416.
Pyle's *Symbol-Digit Test*, 284.

Quality of learning, variations in, 305.

Racial man in the present child, 10.
Radossawljewitsch on forgetting, 322 ff.
Rank of learner, learning process classified according to, 82.
Rat, in maze-threading experiment, 115.
Rate of acquisition, 302.
Rate of forgetting, 319, 320 ff.
Readiness, law of, 114.
Reasoning, 213; inductive and deductive, 219; what stimulates? 217.
Recency, principle of, 188.
Reëducation and mental hygiene, 382.
Reflective learning classified, 82.
Relationships, learning of, 95, 98.
Relearning, importance of frequent, 324.
Repetition in learning, 159.
Response, as related to bond and situation, 84.
Responses, feeling accompaniment of, 39.
Restricted range of animal learning, 122.
Retention, 298 ff.; 319 ff.; number of associations a factor in, 311.
Retentivity, age and maturity factors in, 306; variations in, 307.
Revolutionary War, two methods of teaching, 29.
Rich perceptual experience, importance of, 195.
Richardson, F., 120.
Rote memory test, 299.
Rousseau, 196.
Ruediger, W. C., 356.
Ruger, H. A., 123, 214.
Rugg, H. O., 416.

Satisfaction, 42.
School, function of, in building up knowledge, 94.
School grades, Starch's study of, 262.
School subjects, correlation of abilities in, 257.
Scientific education, 283.
Scolding, as a negative incentive, 246.
Seashore on auditory discrimination, 169.
Seating, importance of comfortable, 253.
Secondary phase of learning, 298 ff.; 319.
Selection of ideational series, 194.
Selective function of attention, 231.
Self, 376 ff.
Sense elements, fusion of, into percepts, 172.
Sense organs, importance of efficient, 250.
Sense-testing, importance of, 170.
Sense-training, 171.
Sensori-motor learning, 153 ff.; classified, 82; conditions of dexterity in, 160; nature of, 155; schoolroom illustrations of, 159.
Sight-spelling, 173.
Similarity in association, 190.
Situation, as related to bond and response, 84.
Skill, as an element in economical performance, 74; as conditioned upon encouragement, 163; as related to interest, 161.
Sleep, 278.
Sleight, W. G., 333, 357.
Socrates, 86.
Sorting letters, 74.
Spearman, F., 169.
Specific learning ability, 266.
Speed, as an element in economical performance, 74.
Standard deviation, as a measure of variability, 409.
Standardized achievement tests, 396; examples of, 398; present limitations of, 397.
Starch, D., 262, 334, 350, 355, 393, 416.
Star-tracing experiments, 118.
Statistical methods, 401 ff.
Stone, E. D., 20.
Strayer, G. D., 12, 17, 100, 229, 256, 318.
Strong, E. K., 17, 58, 152, 178.
Studies of teachers' marks, 392.
Study, wastefulness in, 234.
Sub-cortical levels, transference of control to, 73.

Substitution, as a method of modifying original responses, 15.
Substitution test, 61.
Success, a condition of mental health, 385.
Successful achievement, pride in, 23.
Suggestion and the teacher, 388.
Swift, E. J., 147, 156, 178.
Sympathetic nervous system, relation of, to lower level action, 72.
Synthesis in perception-building, 168.

Tabulation of the results of learning, 391.
Tachistoscopy, 154, 175.
Tait's Labyrinth Puzzle, 103.
Teacher, and suggestion, 388; as mental hygienist, 379; place of, in motivated work, 27 ff.
Teaching, variety in, 292.
Technique of transfer experiments, 358.
Telegraphic code, 146.
Temperature, as affecting attention, 252.
Terman, L. M., 180, 260, 278, 390.
Tests of learning capacity, 281.
Thinking, as preceding memorizing, 210.
Thomson, J. Arthur, 206.
Thorndike, E. L., 17, 80, 120, 125, 127, 265, 354.
Thorndike-McCall Reading Scale, 400.
Threats, as negative incentives, 246.
Time interval in learning, 325.
Toxins of fatigue, 272.
Training, transference of, 247 ff.
Transfer experiment, 360 ff.
Transfer through identical elements, 371 ff.
Transference of training, 347 ff.
Trial and error, fundamental factors in, 112; in children, 123; in human and animal learning, 114; in new situations, 215; learning classified, 82; method of, 109.
Trials, distribution of, in economical learning, 118.
Typewriting, by a skilled operative, 67; first experience at, 64; with an altered keyboard, 126.

Uniformity of ability, 22, 59 ff.; empirical evidence of, 259; experimental evidence of, 260.
Unstable personality, 378.
Utilitarian interpretation of educative aim, 63.

Variability, measures of, 408.
Variety in teaching, 292.
Verbal ideation, 328.
Verification, as fourth step in deductive learning, 227.
Visual ideation, 328.
Vitalized effort, 26.
Volition and personality, 386.

Wastefulness in study, 234.
Watkins, F. W., 30.
Watson, J. B., 109, 118, 127, 129.
Weight discrimination, 154.
Wells, H. G., 233.
Whipple, G. M., 256, 273, 284, 303, 340, 350.
Whipple's tests, 284 ff.
White, W. A., 390.
Whole method of learning, 299, 307.
Whole-part method of learning, 308.
Wilson, H. B., 37, 48, 162, 199.
Wilson, G. M., 37, 48, 162, 199.
Winch, W. H., 166, 169, 333, 357.
Woodworth, R. S., 354.
Wright, W. R., 116.

Yerkes, R. M., 119, 127.
Yoakum, C. S., 120.

1. What is the usually accepted goal of the learning process
2. How is it thought to be reached.
3. Define mental hygiene
4. What is meant by saying that some school adjustment is negetive
5. What is the teachers problem with reference to positive adjustment
6. What elements enter into personality and what is the place of each.
7. What elements of personality should a teacher have
8. Why is the teacher's personality important
9.

185

E.V. Jones.

E.V. Jones

E

E V

datacolor
0 inch
1
2
3
4
5
6
WESTC
30 29 28 27 26 25 24 23 22 21 20 19 18 17 16